OSHA REFERENCE MANUAL

OCCUPATIONAL SAFETY AND HEALTH COMPLIANCE SIMPLIFIED

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Bowman Merritt
Publisher

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OVERVIEW: SUBPART Z

TOXIC AND HAZARDOUS SUBSTANCES

This subpart, one of the longest and most complex of OSHA regulations, addresses the topic of employee exposure to toxic and hazardous materials, and sets out requirements for exposure limits, safe work practices, monitoring, employee protection, etc.

Section 1910.1000, air contaminants, contains three charts (Z-1-A, Z-2, and Z-3), outlining time-weighted average limits, ceiling values, and ceiling concentration limits for hundreds of chemicals (see pages Z-App-1 thru Z-App-8).

More specific standards have been developed for those chemicals shown to be most hazardous, such as asbestos, vinyl chloride, lead, inorganic arsenic, cotton dust, and many others (see list below).

Also under this subpart falls the hazard communication standard, 1910.1200, which is now applicable to all industries. This standard requires labeling, material safety data sheets, and employee training for all hazardous materials in the workplace. For a more complete discussion of the hazard communication standard, see page Z-101.

Finally, standard 1910.1450 sets requirements for hazardous chemicals used in laboratories. This section applies to all workplaces where laboratory workers are exposed to hazardous chemicals.

Specific sections of the standard covered in the checklist are:

Std.		Page No.
1910.1000	**Air contaminants**	Z-01
1910.1001	**Asbestos**	Z-02
1910.1002	**Coal tar pitch volatiles**	Z-06
1910.1003	**4-Nitrobiphenyl**	Z-06,Z-06c
1910.1004	**alpha-Naphthylamine**	Z-06a,Z-06c
1910.1005	**4,4'-Methylene bis (2-chloraniline) (advisory only)**	Z-06a,Z-06c
1910.1006	**Methyl chloromethyl ether**	Z-06a,Z-06c
1910.1007	**3,3'-Dichlorobenzidine (and its salts)**	Z-06a,Z-06c
1910.1008	**bis-Chloromethyl ether**	Z-06a,Z-06c
1910.1009	**beta-Naphthylamine**	Z-06b,Z-06c
1910.1010	**Benzidine**	Z-06b,Z-06c
1910.1011	**4-Aminodiphenyl**	Z-06b,Z-06c
1910.1012	**Ethyleneimine**	Z-06b,Z-06c
1910.1013	**beta-Propiolactone**	Z-06b,Z-06c
1910.1014	**2-Acetylaminofluorene**	Z-06b,Z-06c
1910.1015	**4-Dimethylaminoazobenzene**	Z-06c
1910.1016	**N-Nitrosodimethylamine**	Z-06c
1910.1017	**Vinyl chloride**	Z-10
1910.1018	**Inorganic arsenic**	Z-14

1910.1025	Lead	Z-17
1910.1027	Cadmium	Z-17j
1910.1028	Benzene	Z-19
1910.1029	Coke oven emissions	Z-24
1910.1030	Bloodborne pathogens	Z-33
1910.1043	Cotton dust	Z-47
1910.1044	1, 2-dibromo-3-chloropropane	Z-48
1910.1045	Acrylonitrile	Z-49
1910.1047	Ethylene oxide	Z-53
1910.1048	Formaldehyde	Z-58
1910.1050	Methylenedianiline	Z-64
1910.1200	Hazard communication	Z-101
1910.1450	Occupational exposure to hazardous chemicals in laboratories	Z-113

GENERAL DEFINITIONS — SUBPART Z

Assistant Secretary. The Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee.

Authorized person. Any person specifically authorized by the employer whose duties require him or her to enter a regulated area or any person entering such an area as a designated representative of employees for the purpose of exercising an opportunity to observe monitoring and measuring procedures.

Director. The Director, National Institute for Occupational Safety and Health, U.S. Department of Health and Human Services, or designee.

OSHA Area Director. The Director for the Occupational Safety and Health Area Office having jurisdiction over the geographic area in which the employer's establishment is located.

OSHA Area Office. The Area Office of the Occupational Safety and Health Administration having jurisdiction over the geographic area where the affected workplace is located.

Definitions applicable to 1910.1000, Air contaminants:

The following definitions are applicable to the Final Rule Limits columns of Table Z-1A on page Z-App-2.

Ceiling. The employee's exposure which shall not be exceeded during any part of the work day. If instantaneous monitoring is not feasible, then the ceiling shall be assessed as a 15-minute time weighted average exposure which shall not be exceeded at any time during the working day.

Short term exposure limit (STEL). The employee's 15-minute time weighted average exposure which shall not be exceeded at any time during the work day unless another time limit is specified in a parenthetical notation below the limit. If another time period is specified, the time weighted average exposure over that time period shall not be exceeded at any time during the working day.

Time weighted average (TWA). The employee's average airborne exposure in any 8-hour work shift of a 40-hour work week which shall not be exceeded.

NOTE: The terms "substance", "air contaminant", and "material" are equivalent in meaning for this standard.

Definitions applicable to 19100.1001, Asbestos:

Action level. An airborne concentration of asbestos of 0.1 fiber per cubic centimeter (f/cc) of air calculated as an eight (8) hour time weighted average.

Asbestos. Includes chrysotile, amosite, crocidolite, tremolite asbestos, anthophyllite asbestos, actinolite asbestos, and any of these minerals that have been chemically treated, and/or altered.

Employee exposure. Exposure to airborne asbestos, anthophyllite asbestos, or a combination of these minerals that would occur if the employee were not using respiratory protective equipment.

Fiber. A particulate form of asbestos, 5 micrometers or longer, with a length-to-diameter ratio of at least 3:1.

High-efficiency particulate air (HEPA) filter. A filter capable of trapping and retaining at least 99.97% of 0.3 micrometer diameter monodispersed particles.

Regulated area. An area established by the employer to demarcate areas where airborne concentrations of asbestos exceed or can reasonably be expected to exceed the permissible exposure limit.

Definitions applicable to 1910.1017, Vinyl chloride:

Action level. A concentration of vinyl chloride of 0.5 ppm averaged over an 8-hour work day.

Emergency. Any occurrence, such as, but not limited to, equipment failure, or operation of a relief device which is likely to, or does, result in massive release of vinyl chloride.

Fabricated product. A product made wholly or partly from polyvinyl chloride, and which does not require further processing at temperatures, and for times, sufficient to cause mass melting of the polyvinyl chloride resulting in the relese of vinyl chloride.

Hazardous operation. Any operation, procedure, or activity where a release of either vinyl chloride liquid or gas might be expected as a consequence of the operation or because of an accident in the operation, which would result in an employee exposure in excess of the permissible exposure limit.

Polyvinyl chloride. Polyvinyl chloride homopolymer or copolymer before such is converted to a fabricated product.

Vinyl chloride. Vinyl chloride monomer.

Definitions applicable to 1910.1018, Inorganic arsenic:

Action level. A concentration of inorganic arsenic of 5 micrograms per cubic meter of air (5 ug/m^3) averaged over any eight (8) hour period.

Inorganic arsenic. Copper aceto-arsenite and all inorganic compounds containing arsenic except arsine, measured as arsenic (As).

Definitions applicable to 1910.1025, Lead:

Action level. Employee exposure, without regard to the use of respirators, to an airborne concentration of lead of 30 micrograms per cubic meter of air (30 ug/m^3) averaged over an 8-hour period.

Lead. Metallic lead, all inorganic lead compounds, and organic lead soaps. Excluded from this definition are all other organic lead compounds.

Definitions applicable to 1910.1027, Cadmium:

Action level (AL). Action level is defined as an airborne concentration of cadmium of 2.5 micrograms per cubic meter of air (2.5 μg/m^3), calculated as an 8-hour time-weighted average (TWA).

Employee exposure. Exployee exposure and similar language referring to the air cadmium level to which an employee is exposed means the exposure to airborne cadmium that would occur if the employee were not using respiratory protective equipment.

Final medical determination. The written medical opinion of the employee's health status by the examining physician under paragraphs (l)(3)-(12) of this section or, if multiple physician review under paragraph (l)(13) of this section or the alternative physician determination under paragraph (l)(14) of this section is invoked, it is the final, written medical finding, recommendation or determination that emerges from that process.

High-efficiency particulate (HEPA) air filter. A filter capable of trapping and retaining at least 99.97 percent of mono-dispersed particles of 0.3 micrometers in diameter.

Regulated area. An area demarcated by the employer where an employee's exposure to airborne concentrations of cadmium exceeds, or can reasonably be expected to exceed the permissible exposure limit (PEL).

Definitions applicable to 1910.1029, Coke oven emissions, can be found on page Z-24.

Definitions applicable to 1910.1030, Bloodborne Pathogens:

Assistant Secretary. The Assistant Secretary of Labor for Occupational Safety and Health, or a designated representative.

Blood. Human blood, human blood components, and products made from human blood.

Bloodborne pathogens. Pathogenic microorganisms that are present in human blood and can cause disease in humans. These pathogens include, but are not limited to, hepatitis B virus (HBV) and human immunodeficiency virus (HIV).

Clinical laboratory. A workplace where diagnostic or other screening procedures are performed on blood or other potentially infectious materials.

Contaminated. The presence or the reasonably anticipated presence of blood or other potentially infectious materials on an item or surface.

Contaminated laundry. Laundry that has been soiled with blood or other potentially infectious materials or may contain sharps.

Contaminated sharps. Any contaminated object that can penetrate the skin including, but not limited to, needles, scalpels, broken glass, broken capillary tubes and exposed ends of dental wires.

Decontamination. The use of physical or chemical means to remove, inactivate, or destroy bloodborne pathogens on a surface or item to the point where they are no longer capable of transmitting infectious particles and the surface or item is rendered safe for handling, use or disposal.

Director. The Director of the National Institute for Occupational Safety and Health, U.S. Department of Health and Human Services, or a designated representative.

Engineering controls. Controls (e.g., sharps disposal containers, self-sheathing needles) that isolate or remove the bloodborne pathogens hazard from the workplace.

Exposure incident. A specific eye, mouth, other mucous membrane, non-intact skin or parenteral contact with blood or other potentially infectious materials that results from the performance of an employee's duties.

Handwashing facilities. A facility providing an adequate supply of running potable water, soap and single use towels or hot air drying machines.

HBV. Hepatitis B virus.

HIV. The human immunodeficiency virus.

Licensed healthcare professional. A person whose legally permitted scope of practice allows him or her to independently perform the activities required by paragraph (f) Hepatitis B Vaccination and Post-exposure Evaluation and Follow-up.

Occupational exposure. Reasonably anticipated skin, eye, mucous membrane or parenteral contact with blood or other potentially infectious materials that may result from the performance of an employee's duties.

Other potentially infectious materials.
(1) The following human body fluids: semen, vaginal secretions, cerebrospinal fluid, synovial fluid, pleural fluid, pericardial fluid, peritoneal fluid, amniotic fluid, saliva in dental procedures, any body fluid that is visibly contaminated with blood, and all body fluids in situations where it is difficult or impossible to differentiate between body fluids;
(2) Any unfixed tissue or organ (other than intact skin) from a human (living or dead), and
(3) HIV-containing cell or tissue cultures, organ cultures, and HIV-or HBV-containing culture medium or other solutions; and blood, organs, or other tissues from experimental animals infected with HIV or HBV.

Parenteral. Piercing mucous membranes or the skin barrier through such events as needlesticks, human bites, cuts, and abrasions.

Personal protective equipment. Specialized clothing or equipment worn by an employee for protection against a hazard. General work clothes (e.g., uniforms, pants, shirts or blouses) not intended to function as protection against a hazard are not considered to be personal protective equipment.

Production facility. A facility engaged in industrial-scale, large-volume or high concentration production of HIV or HBV.

Regulated waste. Liquid or semi-liquid blood or other potentially infectious materials; contaminated items that would release blood or other potentially infectious materials in a liquid or semi-liquid state if compressed; items that are caked with dried blood or other potentially infectious materials and are capable of releasing these materials during handling; contaminated sharps; and pathological and microbiological wastes containing blood or other potentially infectious materials.

Research laboratory. A laboratory producing or using research laboratory-scale amounts of HIV or HBV. Research laboratories may produce high concentrations of HIV or HBV but not in the volume found in production facilities.

Source individual. Any individual, living or dead, whose blood or other potentially infectious materials may be a source of occupational exposure to the employee. Examples include, but are not limited to, hospital and clinic patients; clients in institutions for the developmentally disabled; trauma victims; clients of drug and alcohol treatment facilities, residents of hospices and nursing homes; human remains; and individuals who donate or sell blood or blood components.

Sterilize. The use of a physical or chemical procedure to destroy all microbial life including highly resistant bacterial endospores.

Universal precautions. An approach to infection control. According to the concept of universal precautions, all human blood and certain human body fluids are treated as if known to be infectious for HIV, HBV, and other bloodborne pathogens.

Work practice controls. Controls that reduce the likelihood of exposure by altering the manner in which a task is performed (e.g., prohibiting recapping of needles by a two-handed technique).

Definitions applicable to 1910.1043, Cotton Dust:

Blow down. The cleaning of equipment and surfaces with compressed air.

Cotton dust. Dust present in the air during the handling or processing of cotton, which may contain a mixture of many substances including ground up plant matter, fiber, bacteria, fungi, soil, pesticides, non-cotton plant matter, and other contaminants which may have accumulated with the cotton during the growing, harvesting and subsequent processing or storage periods. Any dust present during the handling and processing of cotton through the weaving or knitting of fabrics, and dust present in other operations or manufacturing processes using new or waste cotton fibers or cotton fiber by-products from textile mills are considered cotton dust.

Lint-free respirable cotton dust. Particles of cotton dust of approximately 15 microns or less aerodynamic equivalent diameter.

Verticle elutriator cotton dust sampler. A dust sampler which has a particle size cut-off at approximately 15 microns aerodynamic equivalent diameter when operating at the flow rate of 7.4 ± 0.2 liters per minute.

Yarn manufacturing. All textile mill operations from opening to, but not including, slashing and weaving.

Washed cotton. Cotton which has been thoroughly washed in hot water and is known in the cotton textile trade as purified or dyed. Washed cotton does not include steamed, autoclaved cotton or cotton washed soley in solvents.

Definitions applicable to 1910.1044, 1,2 Dibromo-3-chloropropane:

DBCP. 1,2-dibromo-3-chloropropane, Chemical Abstracts Service Registry Number 96-12-8, including all forms of DBCP.

Emergency. Any occurrence such as, but not limited to equipment failure, rupture of containers, or failure of control equipment which may, or does, result in an unexpected release of DBCP.

Definitions applicable to 1910.1045, Acrylonitrile:

Acrylonitrile (AN). Acrylonitrile monomer, chemical formula $CH_2=CHCN$.

Action level. A concentration of AN of 1 ppm as an eight (8)-hour time-weighted average.

Decontamination. Treatment of materials and surfaces by water washdown, ventilation, or other means, to assure that the materials will not expose employees to airborne concentrations of AN.

Emergency. Any occurrence such as, but not limited to, equipment failure, rupture of containers, or failure of control equipment, which results in an unexpected massive release of AN.

Liquid AN. AN monomer in liquid form, and liquid or semiliquid polymer intermediates, including slurries, suspensions, emulsions, and solutions, produced during the polymerization of AN.

Definitions applicable to 1910.1047, Ethylene oxide, can be found on page Z-53.

Definitions applicable to 1910.1048, Formaldehyde:

Action Level. A concentration of 0.5 part formaldehyde per million parts of air (0.5 ppm) calculated as an eight-hour time-weighted average (TWA).

Emergency. Any occurrence, such as equipment failure, rupture of containers, or failure of control equipment, that results in an uncontrolled released of a significant amount of formaldehyde.

Formaldehyde. The chemical substance, HCHO, Chemical Abstracts Service Registry No. 50-00-0.

Definitions applicable to 1910.1050, Methylenedianiline:

Action Level. A concentration of airborne MDA of 5 ppb as an eight (8)-hour time-weighted average.

Container. Any barrel, bottle, can, cylinder, drum, reaction vessel, storage tank, commercial packaging or the like, but does not include piping systems.

Dermal exposure to MDA. This occurs where employees are engaged in the handling, application or use of mixtures or materials containing MDA, with any of the following non-airborne forms of MDA: Liquid, powdered, granular, or flaked mixtures containing MDA in concentrations greater then 0.1% by weight or volume, and materials other than "finished articles" containing MDA in concentrations greater than 0.1% by weight or volume.

Emergency. Any occurrence such as, but not limited to, equipment failure, rupture of containers, or failure of control equipment which results in an unexpected and potentially hazardous release of MDA.

Employee Exposure. Any exposure to MDA which would occur if the employee were not using respirators or protective work clothing and equipment.

Finished article containing MDA. A manufactured item which is formed to a specific shape or design during manufacture; which has end use function(s) dependent in whole or part upon its shape or design during end use; and, where applicable, is an item which is fully cured by virtue of having been subjected to the conditions (temperature, time) necessary to complete the desired chemical reaction.

4,4' Methylenedianiline or MDA. The chemical, 4,4'-diaminodiphenylmethane, Chemical Abstract Service Registry number 101-77-9, in the form of a vapor, liquid, or solid. The definition also includes the salts of MDA.

Regulated areas. Area where airborne concentrations of MDA exceed or can reasonably be expected to exceed, the permissible exposure limits, or where dermal exposure to MDA can occur.

STEL. Short term exposure limit as determined by any 15 minute sample period.

Definitions applicable to 1910.1200, Hazard communication, can be found on page Z-105.

Definitions applicable to 1910.1450, Occupational exposure to hazardous chemicals in laboratories:

Action level. A concentration designated in 29 CFR part 1910 for a specific substance, calculated as an eight-hour time-weighted average, which initiates certain activities such as exposure monitoring and medical surveillance.

Assistant Secretary. The Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee.

Carcinogen. (See select carcinogen.)

Chemical Hygiene Officer. An employee who is designated and qualified by training or experience to provide technical guidance in the development and implementation of the Chemical Hygiene Plan. (This definition is not intended to place limitations on the position, description, or job classification that he designated individual shall hold within the employer's organizational structure.)

Chemical Hygiene Plan (CHP). A written program developed and implemented which sets forth procedures, equipment, personal protective equipment, and work practices that are capable of protecting employees from the health hazards presented by hazardous chemicals used in that particular workplace and meets the requirements of paragraph (e) of this section.

Combustible liquid. Any liquid having a flashpoint at or above 100° F (37.8° C), but below 200° F (93.3° C), except any mixture having components with flashpoints of 200° F (93.3° C), or higher, the total volume of which make up 99% or more of the total volume of the mixure.

Compressed gas. A gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psi at 70° F (21.1° C); or a gas or mixture of gases having, in a container, an absolute preceeding 104 psi at 130° F (54.4° C) regardless of the pressure at 70%MG (21.1° C); or a liquid having a vapor pressure exceeding 40 psi at 100° F (37.8° C) as determined by ASTM D-323-72.

Designated area. An area which may be used for work with "select carcinogens," reproductive toxins, or substances which have a high degree of acute toxicity. A designated area may be the entire laboratory, and area of a laboratory, or a device such as a laboratory hood.

Emergency. Any occurrence such as, but not limited to, equipment failure, rupture of containers, or failure of control equipment which results in an uncontrolled release of a hazardous chemical into the workplace.

Employee. An individual employed in a laboratory workplace who may be exposed to hazardous chemicals in the course of his or her assignments.

Explosive. A chemical that causes a sudden, almost instantaneous, release of pressure, gas, and heat when subjected to sudden shock, pressure, or high temperature.

Flammable. A chemical that falls into one of the following catagories:

Aerosol flammable — an aerosol that, when tested by the method described in 16 CFR 1500.45, yields a flame protection exceeding 18 inches at full valve opening;

Gas flammable — a gas that at ambient temperature and pressure forms a flammable mixture with air at concentrations of 13% by volume or less; or

Liquid flammable — any liquid having a flashpoint of below 100° F (37.8° C), except any mixture having components with flashpoints of 100° F (37.8° C) or higher, the total of which make up 99% or more of the total volume of the mixture.

Flashpoint. The minimum temperature at which a liquid gives off vapor in sufficient concentration to ignite.

Hazardous chemical. A chemical that can cause acute or chronic health effects in exposed employees.

Laboratory. A facility where the laboratory use of hazardous chemicals occurs.

Laboratory scale. Work with substances in which the containers used for reactions, transfers, and other handling of substances are designed to be easily and safely manipulated by one person.

Laboratory-type hood. A device located in a laboratory (enclosed on five sides with a movable sash or fixed partial enclosure on the remaining sides) which is constructed and maintained to draw air from the laboratory and to prevent or minimize the escape of air contaminants; and allows chemical manipulations to be conducted without insertion of any portion of the employee's body other than hands and arms.

Oxidizer. A chemical that initiates combustion in other material, thereby causing fire either of itself or through the release of oxygen or other gases.

Physical hazard. A chemical that is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer, pyrophoric, or unstable or water-reative.

Reproductive toxins. Chemicals which affect the reproductive capabilities, including chromosomal damage.

Select carcinogen. Any substance which is regulated by OSHA as a carcinogen; is listed under the category "known to be carcinogens" in the Annual Report on Carcinogens; is listed under Group 1 by the International Agency for Research on Cancer Monographs (IARC); is listed in Group 2A or 2B by the IARC; or is under the category "carcinogens" by the National Toxicology Program.

Unstable. A chemical which is the pure state, or as produced or transported will vigorously polymerize, decompose, condense, or will become self-reactive under conditions of shocks, pressure, or temperature.

Water-reactive. A chemical that reacts with water to relase a gas that is either flammable or presents a health hazard.

YES	NO	N/A

NOTE: The exposure limits specified in the "Final rule limits" columns of Table Z-1-A have been revoked. This revocation reflects the Court of Appeals decision in *AFL-CIO v. OSHA*, 965 F.2d 962 (11th Cir., 1992) vacating those limits. Enforcement of those limits was suspended starting March 23, 1993.

The permissible exposure limits specified in the "Transitional limits" columns of Table Z-1-A and in Tables Z-2 and Z-3 have remained in effect and are being enforced.

In order to effectuate this action, Table Z-1-A is being removed and a Table Z-1 is being added which includes exposure limits which were included in Table Z-1 before 1989.

(a) Table Z-1

Substances with Limits Preceded by "C" — Ceiling Values

Are employees exposed to the materials listed in Table Z-1, of his section preceded by a "C" limited to the threshold limit values of the material in question? **(a)(1)**

If instantaneous monitoring is not feasible, is the ceiling assigned as a 15-minute time-weighted average exposure which shall not be exceeded at any time during the working day? **(a)(1)**

Other Substances — 8-Hour Time-Weighted Averages

Does an employee's exposure to any substance in Table Z-1 with an exposure limit which is not preceded with a "C", not exceed the 8-hour time-weighted average given for that substance in any 8-hour work shift of a 40-hour work week? **(a)(2)**

(b) Table Z-2

8-Hour Time-Weighted Averages

Are employees' exposure to materials listed in Table Z-2 limited to the threshold limit values in the 8-hour time weighted coverage column of the table for the material being used? **(b)(1)**

If an employee's exposure to a material listed in Table Z-2 exceeds the 8-hour time limit average, is he limited to an exposure of the material as listed in the acceptable ceiling concentration column of Table Z-2? **(b)(1)**

Acceptable Ceiling Concentrations

If an employee's exposure exceeds the acceptable concentration values, is he limited to the concentration of material involved with the maximum duration of time as listed in the acceptable maximum peak above the acceptable ceiling concentrations for 8-hour shift columns of Table Z-2? **(b)(2)**

EXAMPLE: During an 8-hour work shift, an employee may be exposed to a concentration of above 25 ppm. (but never above 50 ppm.) only for a maximum period of ten minutes, such exposure must be compensated by exposures to concentrations less than the 10 ppm., so that the cumulative exposure for the entire 8-hour work shift does not exceed a weighted average of 10 ppm. **(b)(3)**

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YES	NO	N/A

(c) Table Z-3

Are employee exposures to those materials listed in Table Z-3, limited to the threshold limit values as established in that table? **(c)**

(d) Computation Formulae

NOTE: The computation formula which shall apply to employee exposure to more than one substance for which 8-hour time weighted averages are listed in subpart Z of 29 CFR part 1910 in order to determine whether an employee is exposed over the regulatory limit is as follows:

The cumulative exposure for an 8-hour work shift shall be computed as follows: **(d)(1)(i)**

$E = (C_a/T_a + C_b/T_b + \ldots C_n/T_n) \div 8$

Where:

E is the equivalent exposure for the working shift.

C is the concentration during any period of time T where the Concentration remains constant.

T is the duration in hours of the exposure at the concentration C.

The value of E shall not exceed the 8-hour time weighted average specified in subpart Z of 29 CFR part 1910 for the substance involved.

To illustrate the formula prescribed in paragraph (d)(1)(i) of this section, assume that Substance A has an 8-hour time weighted average limit of 100 ppm noted in Table Z-1. Assume that an employee is subject to the following exposure: **(d)(1)(ii)**

Two hours exposure at 150 ppm

Two hours exposure at 75 ppm

Four hours exposure at 50 ppm

Substituting this information in the formula, we have

$2 \times 150 + 2 \times 75 + 4 \times 50 \div 8 = 81.25$ ppm

Since 81.25 ppm is less than 100 ppm, the 8-hour time weighted average limit, the exposure is acceptable.

In case of a mixture of air contaminants an employer shall compute the equivalent exposure as follows: **(d)(2)(i)**

$E_m = (C_1$ divided by $L_1 \times C_2 \div L_2 \times \ldots C_n \div L_n)$

Where:

E_m is the equivalent exposure for the mixture.

C is the concentration of a particular contaminant.

L is the exposure limit for that substance specified in Subpart Z of 29 CFR Part 1910.

The value of E_m shall not exceed unity (1).

To illustrate the formula prescribed in paragraph (d)(2)(i) of this section, consider the following exposures: **(d)(2)(i)**

Substance	Actual concentration of 8-hour exposure (ppm)	8 hr.TWA PEL (ppm)
B	500	1,000
C	45	200
D	40	200

Substituting in the formula, we have:

$$E_m = 500 \div 1{,}000 \times 45 \div 200 \times 40 \div 200$$

$$E_m = 0.500 \times 0.225 \times 0.200$$

$$E_m = 0.925$$

Since E(m) is less than unity (1), the exposure combination is within acceptable limits.

(e) Engineering Controls

Have administrative or engineering controls for limiting the employee exposure to the materials listed in the tables been determined?

YES	NO	N/A

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If administrative and engineering controls have been determined, have they been implemented whenever feasible? **(e)**

When administrative and engineering controls are not feasible to achieve full compliance, is protective equipment or any other protective measure used to keep the exposure of employees within the limits prescribed in the tables? **(e)**

Has a competent industrial hygienist or other technically qualified person approved the use of any equipment and/or technic a measures used to limit the employee exposure? **(e)**

If respirators are used to protect employees, do they comply with Sec. 1910.134? **(e)**

(f) Effective Dates

NOTE: The exposure limits specified have been in effect with the method of compliance specified in paragraph (e) of this section since May 29, 1971.

YES	NO	N/A

TABLE Z-1 — Limits For Air Contaminants

Substance	CAS No. (c)	PEL[1] ppm (a)	PEL[1] mg/m³ (b)	Skin designation
Acetaldehyde	75-07-0	200	360	
Acetic acid	64-19-7	10	25	
Acetic anhydride	108-24-7	5	20	
Acetone	67-64-1	1000	2400	
NOTE: The Acetone TWA has been stayed for certain "doffers in the cellulose acetate fiber industry until Sept. 1, 1990 and until the decision on the merits of the Eleventh Circuit Court of Appeals in case No. 89-7073. (FR 54:36767, Sept. 5, 1989)				
Acetonitrile	75-05-8	40	70	
2-Acetylaminofluorine: see 1910.1014	53-96-3			
Acetylene dichloride, see 1,2-Dichloroethylene				
Acetylene tetrabromide	79-27-6	1	14	
Acetylsalicylic acid (Aspirin)	50-78-2			
Acrolein	107-02-8	0.1	0.25	
Acrylamide	79-06-1		0.3	X
Acrylic acid	79-10-7			
Acrylonitrile; see 1910.1045	107-13-1			
Aldrin	309-00-2		0.25	X
Allyl alcohol	107-18-6	2	5	X
Allyl chloride	107-05-1	1	3	
Allyl glycidyl ether (AGE)	106-92-3	(C)10	(C)45	
Allyl propyl disulfide	2179-59-1	2	12	
alpha-Alumina	1344-28-1			
Total dust			15	
Respirable fraction			5	
Aluminum (as Al) Metal	7429-90-5			
Total dust			15	
Respirable fraction			5	
Pyro powders				
Welding fumes***				
Soluble salts				
Alkyls				
4-Aminodiphenyl; see 1910.1011	92-67-1			
2-Aminoethanol, see Ethanolamine				
2-Aminopyridine	504-29-0	0.5	2	
Amitrole	61-82-5			
Ammonia	7664-41-7	50	35	
Ammonium chloride fume	12125-02-9			
Ammonium sulfamate	7773-06-0			
Total dust			15	
Respirable fraction			5	
n-Amyl acetate	628-63-7	100	525	
sec-Amyl acetate	626-38-0	125	650	
Aniline and homologs	62-53-3	5	19	X
Anisidine (o, p-isomers)	29191-52-4		0.5	X
Antimony and compounds (as Sb)	7440-36-0		0.5	
ANTU (alpha Naphthylthiourea)	86-88-4		0.3	
Arsenic, organic compounds (as As)	7440-38-2		0.5	
Arsenic, inorganic compounds (as As); see 1910.1018	7440-38-2			
Arsine	7784-42-1	0.05	0.2	
Asbestos; see 1910.1001 and 1910.1101	Varies			
Atrazine	1912-24-9			
Azinphos-methyl	86-50-0		0.2	X
Barium, soluble compounds (as Ba)	7440-39-3		0.5	
Barium sulfate	7727-43-7			
Total dust			15	
Respirable fraction			5	
Benomyl	17804-35-2			
Total dust			15	
Respirable fraction			5	
Benzene; see 1910.1028	71-43-2			
See Table Z-2 for the limits applicable in the operations or sectors excluded in 1910.1028[4]				
Benzidine; see 1910.1010	92-87-5			
p-Benzoquinone; see Quinone				
Benzo(a)pyrene; see Coal tar pitch volatiles				
Benzoyl peroxide	94-36-0		5	
Benzyl chloride	100-44-7	1	5	
Beryllium and beryllium compounds (as Be)	7440-41-7		Tbl. Z-2	
Biphenyl, see Diphenyl				
Bismuth telluride, Undoped	1304-82-1			
Total dust			15	
Respirable fraction			5	
Bismuth telluride, Se-doped				
Borates, tetra, sodium salts				
Anhydrous	1330-43-4			
Decahydrate	1303-96-4			
Pentahydrate	12179-04-3			
Boron oxide	1303-86-2			
Total dust			15	
Boron tribromide	10294-33-4			
Boron trifluoride	7637-07-2	(C)1	(C)3	
Bromacil	314-40-9			

TABLE Z-1 — Limits For Air Contaminants — Continued

Substance	CAS No. (c)	PEL[1] ppm (a)	PEL[1] mg/m³ (b)	Skin designation
Bromine	7726-95-6	0.1	0.7	
Bromine pentafluoride	7789-30-2			
Bromoform	75-25-2	0.5	5	X
Butadiene (1, 3-Butadiene)	106-99-0	1000	2200	
Butane	106-97-8			
Butanethol; see Butyl mercaptan				
2-Butanone (Methyl ethyl ketone)	78-93-3	200	590	
2-Butoxyethanol	111-76-2	50	240	X
n-Butyl acetate	123-86-4	150	710	
sec-Butyl acetate	105-46-4	200	950	
tert-Butyl acetate	540-88-5	200	950	
Butyl acrylate	141-32-2			
n-Butyl alcohol	71-36-3	100	300	
sec-Butyl alcohol	78-92-2	150	450	
tert-Butyl alcohol	75-65-0	100	300	
Butylamine	109-73-9	(C)5	(C)15	X
tert-Butyl chromate (as CrO3)	1189-85-1		(C)0.1	X
n-Butyl glycidyl ether (BGE)	2426-08-6	50	270	
n-Butyl lactate	138-22-7			
Butyl mercaptan	109-79-5	10	35	
o-sec-Butylphenol	89-72-5			
p-tert-Butyltoluene	98-51-1	10	60	
Cadmium fume (as Cd)	7440-43-9		Tbl. Z-2	
See 1910.1027. See Table Z-2 for the exposure limits for any operations or sectors where the exposure limits in 1910.1027 are stayed or otherwise not in effect.				
Cadmium dust (as Cd)	7440-43-9		Tbl. Z-2	
See 1910.1027. See Table Z-2 for the exposure limits for any operations or sectors where the exposure limits in 1910.1027 are stayed or otherwise not in effect.				
Cadmium carbonate	1317-65-3			
Total dust			15	
Respirable fraction			5	
Calcium cyanamide	156-62-7			
Calcium hydroxide[i]	1305-62-0			
Calcium oxide[j]	1305-78-8		5	
Calcium silicate	1344-95-2			
Total dust			15	
Respirable fraction			5	
Calcium sulfate	7778-18-9			
Total dust			15	
Respirable fraction			5	
Camphor, synthetic	76-22-2		2	
Caprolactam	105-60-2			
Dust				
Vapor				
Captafol (Difolatan[R])	2425-06-1			
Captan	133-06-2			
Carbaryl (Sevin[R])	63-25-2		5	
Carbofuran (Furadan[R])	1563-66-2			
Carbon black	1333-86-4		3.5	
Carbon dioxide	124-38-9	5000*	9000	
Carbon disulfide	75-15-0	Tbl. Z-2		
Carbon monoxide	630-08-0	50	55	
Carbon tetrabromide	558-13-4			
Carbon tetrachloride	56-23-5	Tbl. Z-2		
Carbonyl fluoride	353-50-4			
Catechol (Pyrocatechol)	120-80-9			
Cellulose	9004-34-6			
Total dust			15	
Respirable fraction			5	
Cesium hydroxide	21351-79-1			
Chlordane	57-74-9		0.5	X
Chlorinated camphene	8001-35-2		0.5	X
Chlorinated diphenyl oxide	55720-99-5		0.5	
Chlorine	7782-50-5	(C)1	(C)3	
Chlorine dioxide	10049-04-4	0.1	0.3	
Chlorine trifluoride	7790-91-2	(C)0.1	(C)0.4	
Chloroacetaldehyde	107-20-0	(C)1	(C)3	
a-Chloroacetophenone (Phenacyl chloride)	532-27-4	0.05	0.3	
Chloroacetyl chloride	79-04-9			
Chlorobenzene	108-90-7	75	350	
o-Chlorobenzylidine malononitrile	2698-41-1	0.05	0.4	
Chlorobromomethane	74-97-5	200	1050	
2-Chloro-1,3-butadiene; see b-Chloroprene				
Chlorodifluoromethane	75-45-6			
Chlorodiphenyl (42% Chlorine) (PCB)	53469-21-9		1	X
Chlorodiphenyl (54% Chlorine) (PCB)	11097-69-1		0.5	X
1-Chloro-2,3-epoxypropane; see Epichlorohydrin				
2-Chloroethanol; see Ethylene chlorohydrin				
Chloroethylene; see Vinyl chloride				

TABLE Z-1 — Limits For Air Contaminants — Continued

Substance	CAS No. (c)	PEL[1] ppm (a)	PEL[1] mg/m³ (b)	Skin designation
Chloroform (Trichloromethane)	67-66-3	(C)50	(C)240	
bis (Cholromethyl) ether; see 1910.1006	542-88-1			
Chloromethyl methyl ether; see 1910.1006	107-30-2			
1-Chloro-1-nitropropane	600-25-9	20	100	
Chloropentafluoroethane	76-15-3			
Chloropicrin	76-06-2	0.1	0.7	
beta-Chloroprene	126-99-8	25	90	X
o-Chlorostyrene	2039-87-4			
o-Chlorotoluene	95-49-8			
2-Chloro-6-trichloro-methyl pyridine	1929-82-4			
Total dust			15	
Respirable fraction			5	
Chlorpyrifos	2921-88-2			
Chromic acid and chromates (as CrO_3)	7440-47-3		Tbl. Z-2	
Chromium (II) compounds (as Cr)	7440-47-3		0.5	
Chromium (III) compounds (as Cr)	7440-47-3		0.5	
Chromium metal (as Cr)	7440-47-3		1	
Chrysene; see Coal tar pitch volatiles				
Clopidol	2971-90-6			
Total dust			15	
Respirable fraction			5	
Coal dust (less than 5% SiO_2), Respirable fraction			Tbl. Z-3	
Coal dust (greater than or equal to 5% SiO_2), respirable quartz fraction			Tbl. Z-3	
Coal tar pitch volatiles (benzene soluble fraction), anthracene, BaP, phenanthrene, acridine, chrysene, pyrene	65966-93-2		0.2	
Cobalt metal, dust, and fume (as Co)	7440-48-4		0.1	
Cobalt carbonyl (as Co)	10210-68-1			
Cobalt hydrocarbonyl (as Co)	16842-03-8			
Coke oven emissions; see 1910.1029				
Copper	7440-50-8			
Fume (as Cu)			0.1	
Dust and mists (as Cu)			1	
Cotton dust (raw)			1	
This 8-hour TWA applies to respirable dust as measured by a vertical elutriator cotton dust sampler or equivalent instrument. The time-weighted average applies to the cotton waste processing operations of waste recycling (sorting, blending, cleaning and willowing) and gametting. See also 1910.1043 for cotton dust limits applicable to other sectors.				
Crag herbicide (Sesone)	136-78-7			
Total dust			15	
Respirable fraction			5	
Cresol (all isomers)	1319-77-3	5	22	X
Crotonaldehyde	123-73-9; 4170-30-3	2	6	
Crufomate	299-86-5			
Cumene	98-82-8	50	245	X
Cyanamide	420-04-2			
Cyanides (as CN)	Varies with compound		5	
Cyanogen	460-19-5			
Cyanogen chloride	506-77-4			
Cyclohexane	110-82-7	300	1050	
Cyclohexanol	108-93-0	50	200	
Cyclohexanone	108-94-1	50	200	
Cyclohexene	110-83-8	300	1015	
Cyclohexylamine	108-91-8			
Cyclonite	121-82-4			
Cyclopentadiene	542-92-7	75	200	
Cyclopentane	287-92-3			
Cyhexatin	13121-70-5			
2,4-D (Dichlorylphenoxyacetic acid)	94-75-7		10	
Decaborane	17702-41-9	0.05	0.3	X
Demeton (Systox®)	8065-48-3		0.1	X
Dichlorodiphenyltrichloroethane (DDT)	50-29-3		1	X
Dichlorvos (DDVP)	62-73-7		1	X
Diacetone alcohol (4-hydroxy-4-methyl-2-pentanone)	123-42-2	50	240	
50				
1,2-Diaminoethane; see Ethylenediamine				
Diazinon	333-41-5			
Diazomethane	334-88-3	0.2	0.4	
Diborane	19287-45-7	0.1	0.1	
1,2-Dibromo-3-chloropropane; see 1910.1044	96-12-8			
2-N-Dibutylaminoethanol	102-81-8			
Dibutyl phosphate	107-66-4	1	5	
Dibutyl phthalate	84-74-2		5	
Dichloroacetylene	7572-29-4			
o-Dichlorobenzene	95-50-1	(C)50	(C)300	
p-Dichlorobenzene	106-46-7	75	450	
3,3'-Dichlorobenzidine; see 1910.1007	91-94-1			

TABLE Z-1 — Limits For Air Contaminants — Continued

Substance	CAS No. (c)	PEL[1] ppm (a)	PEL[1] mg/m³ (b)	Skin designation
Dichlorodifluoromethane	75-71-8	1000	4950	
1,3-Dichloro-5,5-dimethyl hydantoin	118-52-5		0.2	
1,1-Dichloroethane	75-34-3	100	400	
1,2-Dichlorethylene	540-59-0	200	790	
Dichloroethyl ether	111-44-4	(C)15	(C)90	X
Dichloromethane; see Methylene chloride				
Dichloromonofluoromethane	75-43-4	1000	4200	
1,1-Dichloro-1-nitroethane	594-72-9	(C)10	(C)60	
1,2-Dichloropropane; see Propylenedichloride				
1,3-Dichloropropane	542-75-6			
2,2-Dichloropropionic acid	75-99-0			
Dichlorotetrafluoroethane	76-14-2	1000	7000	
Dicrotophoe	141-66-2			
Dicyclopentadiene	77-73-6			
Dicyclopentadienyl iron	102-54-5			
Total dust			15	
Respirable fraction			5	
Dieldrin	60-57-1		0.25	X
Diethanolamine	111-42-2			
Diethylamine	109-89-7	25	75	
2-Diethylaminoethanol	100-37-8	10	50	X
Diethylene triamine	111-40-0			
Diethyl ether; see Ethyl ether				
Diethyl ketone	96-22-0			
Diethyl phthalate	84-66-2			
Difluorodibromomethane	75-61-6	100	860	
Diglycidyl ether (DGE)	2238-07-5	(C)0.5	(C)2.8	
Dihydroxybenzene; see Hydroquinone				
Diisobutyl ketone	108-83-8	50	290	
Diisopropylamine	108-18-9	5	20	X
4-Dimethylaminoazobenzene; see 1910.1015	60-11-7			
Dimethoxymethane; see Methylal				
Dimethyl acetamide	127-19-5	10	35	X
Dimethylamine	124-40-3	10	18	
Dimethylaminobenzene; see Xylidine				
Dimethylaniline (N-Dimethylaniline)	121-69-7	5	25	X
Dimethylbenzene; see Xylene				
Dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate	300-76-5		3	
Dimethylformamide	68-12-2	10	30	X
2,6-Dimethyl-4-hepta-none; see Diisobutyl ketone				
1,1-Dimethylhydrazine	57-14-7	0.5	1	X
Dimethylphthalate	131-11-3		5	
Dimethyl sulfate	77-78-1	1	5	X
Dinitolmide (3,5-Dinitro-o-toluamide)	148-01-6			
Dinitrobenzene (all isomers)	(alpha-) 528-29-0 (meta-) 99-65-0 (para-) 100-25-1		1	X
Dinitro-o-cresol	534-52-1		0.2	X
Dinitrotoluene	25321-14-6		1.5	X
Dioxane (Diethylene dioxide)	123-91-1	100	360	X
Dioxathion (Delnav)	78-34-2			
Diphenyl (Biphenyl)	92-52-4	0.2	1	
Diphenylamine	122-39-4			
Diphenylmethane diisocyanate, see Methylene bisphenyl isocyanate				
Dipropylene glycol methyl ether	34590-94-8	100	600	X
Dipropyl ketone	123-19-3			
Diquat	85-00-7			
Di-sec, octyl phthalate (Di-2-ethylhexyl-phthalate)	117-81-7		5	
Disulfiram	97-77-8			
Disulfoton	298-04-4			
2,6-Di-tert-butyl-p-cresol	128-37-0			
Diuron	330-54-1			
Divinyl benzene	1321-74-0			
Emery	12415-34-8			
Total dust			15	
Respirable fraction			5	
Endosulfan	115-29-7			
Endrin	72-20-8		0.1	X
Epichlorhydrin	106-89-8	5	19	X
EPN	2104-64-5		0.5	X
1,2-Epoxypropane, see Propylene oxide				
2,3-Epoxy-1-propanol; see Glycidol				
Ethanethiol; see Ethyl mercaptan				
Ethanolamine	141-43-5	3	6	

TABLE Z-1 — Limits For Air Contaminants — Continued

Substance	CAS No. (c)	PEL[1] ppm (a)	PEL[1] mg/m³ (b)	Skin designation
Ethion	563-12-2			
2-Ethoxyethanol	110-80-5	200	740	X
2-Ethoxyethylacetate (Cellosolve acetate)	111-15-9	100	540	X
Ethyl acetate	141-78-6	400	1400	
Ethyl acrylate	140-88-5	25	100	X
Ethyl alcohol (Ethanol)	64-17-5	1000	1900	
Ethylamine	75-04-7	10	18	
Ethyl amyl ketone (5-Methyl-3-heptanone)	541-85-5	25	130	
Ethyl benzene	100-41-4	100	435	
Ethyl bromide	74-96-4	200	890	
Ethyl butyl ketone (3-Heptanone)	106-35-4	50	230	
Ethyl chloride	75-00-3	1000	2600	
Ethyl ether	60-29-7	400	1200	
Ethyl formate	109-94-4	100	300	
Ethyl mercaptan	75-08-1	(C)10	(C)25	
Ethyl silicate	78-10-4	100	850	
Ethylene chlorohydrin	107-07-3	5	16	X
Ethylenediamine	107-15-3	10	25	
Ethylene dibromide	106-93-4	Tbl. Z-2	Tbl. Z-2	Tbl. Z-2
Ethylene dichloride	107-06-2	Tbl. Z-2	Tbl. Z-2	Tbl. Z-2
Ethylene glycol	107-21-1			
Ethylene glycol dinitrate[k]	628-96-6	(C)0.2	(C)1	X
Ethylene glycol methyl acetate; see Methyl cellosolve acetate				
Ethyleneimine; see 1910.1012	151-56-4			
Ethylene oxide; see 1910.1047	75-21-8			
Ethylidine chloride; see 1,1-Dichloroethane				
Ethylidene norbornene	16219-75-3			
N-Ethylmorpholine	100-74-3	20	94	X
Fenamiphos	22224-92-6			
Fensulfothion (Dasanit)	115-90-2			
Fenthion	55-38-9			
Ferbam	14484-64-1			
Total dust			15	
Ferrovanadium dust	12604-58-9		1	
Fluoride (as F)	Varies with compound		2.5	
Fluorine	7782-41-4	0.1	0.2	
Fluorotrichloromethane (Trichlorofluoromethane)	75-69-4	1000	5800	
Fonofos	944-22-9			
Formaldehyde; see 1910.1048; see Table Z-2 for operations or sectors excluded from 1910.1048 or for which limit(s) is (are) stayed	50-00-0			
Formamide	75-12-7			
Formic acid	64-18-6	5	9	
Furfural	98-01-1	5	20	X
Furfuryl alcohol	98-00-0	50	200	
Gasoline	8006-61-9			
Germanium tetrahydride	7782-65-2			
Glutaraldehyde	111-30-8			
Glycerin (mist)	56-81-5			
Total dust			15	
Respirable fraction			5	
Glycidol	556-52-5	50	150	
Glycol monoethyl ether; see 2-Ethoxyethanol				
Grain dust (oat, wheat, barley)				
Graphite, natural respirable dust	7782-42-5		Tbl. Z-3	
Graphite, synthetic				
Total dust			15	
Respirable fraction			5	
Guthion[k]; see Azinphos methyl				
Gypsum	13397-24-5			
Total dust			15	
Respirable fraction			5	
Hafnium	7440-58-6		0.5	
Heptachlor	76-44-8		0.5	X
Heptane (n-Heptane)	142-82-5	500	2000	
Hexachlorobutadiene	87-68-3			
Hexachlorocyclo-pentadiene	77-47-4			
Hexachloroethane	67-72-1	1	10	X
Hexachloronaphthalene	1335-87-1		0.2	X
Hexafluoroacetone	684-16-2			
n-Hexane	110-54-3	500	1800	
Hexane isomers	Varies with compound			
2-Hexanone (Methyl n-butyl ketone)	591-78-6	100	410	
Hexone (Methyl isobutyl ketone)	108-10-1	100	410	

TABLE Z-1 — Limits for Air Contaminants — Continued

Substance	CAS No. (c)	PEL[1] ppm (a)	PEL[1] mg/m³ (b)	Skin designation
sec-Hexyl acetate	108-84-9	50	300	
Hexylene glycol	107-41-5			
Hydrazine	302-01-2	1	1.3	X
Hydrogenated terphenyls	61788-32-7			
Hydrogen bromide	10035-10-6	3	10	
Hydrogen chloride	7647-01-0	(C)5	(C)7	
Hydrogen cyanide	74-90-8	10	11	X
Hydrogen fluoride (as F)	7664-39-3	Tbl. Z-2		
Hydrogen peroxide	7722-84-1	1	1.4	
Hydrogen selenide (as Se)	7783-07-5	0.05	0.2	
Hydrogen sulfide	7783-06-4	Tbl. Z-2	Tbl. Z-2	
Hydroquinone	123-31-9		2	
2-Hydroxypropyl acrylate	999-61-1			
Indene	95-13-6			
Indium and compounds (as In)	7440-74-6			
Iodine	7553-56-2	(C)0.1	(C)1	
Iodoform	75-47-8			
Iron oxide fume	1309-37-1			10
Iron pentacarbonyl (as Fe)	13463-40-6			
Iron salts (soluble) (as Fe)	Varies with compound			
Isoamyl acetate	123-92-2	100	525	
Isoamyl alcohol (primary and secondary)	123-51-3	100	360	
Isobutyl acetate	110-19-0	150	700	
Isobutyl alcohol	78-83-1	100	300	
Isooctyl alcohol	26952-21-6			
Isophorone	78-59-1	25	140	
Isophorone diisocyanate	4098-71-9			
2-Isopropoxyethanol	109-59-1			
Isopropyl acetate	108-21-4	250	950	
Isopropyl alcohol	67-63-0	400	980	
Isopropylamine	75-31-0	5	12	
N-Isopropylaniline	768-52-5			
Isopropyl ether	108-20-3	500	2100	
Isopropyl glycidyl ether (IGE)	4016-14-2	50	240	
Kaolin				
Total dust			15	
Respirable fraction			5	
Ketene	463-51-4	0.5	0.9	
Lead inorganic (as Pb); see 1910.1025	7439-92-1			
Limestone	1317-65-3			
Total dust			15	
Respirable fraction			5	
Lindane	58-89-9		0.5	X
Lithium hydride	7580-67-8		0.025	
L.P.G. (liquefied petroleum gas)	68476-85-7	1000	1800	
Magnesite	546-93-0			
Total dust			15	
Respirable fraction			5	
Magnesium oxide fume	1309-48-4			
Total particulate			15	
Malathion	121-75-5			
Total dust			15	X
Maleic anhydride	108-31-6	0.25	1	
Manganese compounds (as Mn)	7439-96-5		(C)5	
Manganese fume (as Mn)	7439-96-5		(C)5	
Manganese cyclopenta-dienyl tricarbonyl (as Mn)	12079-65-1			
Manganese tetroxide (as Mn)	1317-35-7			
Marble	1317-65-3			
Total dust			15	
Respirable fraction			5	
Mercury (aryl and inorganic) (as Hg)	7439-97-6		Tbl. Z-2	
Mercury (organo) alkyl compounds (as Hg)	7349-97-6		Tbl. Z-2	
Mercury (vapor) (as Hg)	7439-97-6		Tbl. Z-2	
Mesityl oxide	141-79-7	25	100	
Methacrylic acid	79-41-4			
Methanethiol; see Methyl mercaptan				
Methomyl (Lannate)	16752-77-5			
Methoxychlor	72-43-5			
Total dust			15	
2-Methoxyethanol; see Methyl cellosolve				
4-Methoxyphenol	150-76-5			
Methyl acetate	79-20-9	200	610	
Methyl acetylene (Propyne)	74-99-7	1000	1650	
Methyl acetylene-propadiene mixture (MAPP)		1000	1800	
Methyl acrylate	96-33-3	10	35	X
Methylacrylonitrile	126-98-7			
Methylal (Dimethoxy-methane)	109-87-5	1000	3100	

TABLE Z-1 — Limits For Air Contaminants — Continued

Substance	CAS No. (c)	PEL[1] ppm (a)	PEL[1] mg/m³ (b)	Skin designation
Methyl alcohol	67-56-1	200	260	
Methylamine	74-89-5	10	12	
Methyl amyl alcohol; see Methyl isobutyl carbinol				
Methyl n-amyl ketone	110-43-0	100	465	
Methyl bromide	74-83-9	(C)20	(C)80	X
Methyl butyl ketone; see 2-Hexanone				
Methyl cellosolve (2-Methoxyethanol)	109-86-4	25	80	X
Methyl cellosolve acetate (2-Methoxyethyl acetate)	110-49-6	25	120	X
Methyl chloride	74-87-3	Tbl. Z-2		
Methyl chloroform (1,1,1-Trichloroethane)	71-55-6	350	1900	
Methyl 2-cyanoacrylate	137-05-3			
Methyl cyclohexane	108-87-2	500	2000	
Methylcyclohexanol	25639-42-3	100	470	
o-Methylcyclohexanone	583-60-8	100	460	X
Methylcyclopentadienyl manganese tricarbonyl (as Mn)	12108-13-3			
Methyl demeton	8022-00-2			
4,4'-Methylene bis (2-chloroaniline) (MBOCA)	101-14-4			
Methylene bis (4-cyclohexylisocyanate)	5124-30-1			
Methylene chloride	75-09-2	Tbl. Z-2		
Methyl ethyl ketone peroxide (MEKP)	1338-23-4			
Methyl formate	107-31-3	100	250	
Methyl hydrazine (Monomethyl hydrazine)	60-34-4	(C)0.2	(C)0.35	X
Methyl iodide	74-88-4	5	28	X
Methyl isoamyl ketone	110-12-3			
Methyl isobutyl carbinol	108-11-2	25	100	X
Methyl isobutyl ketone, see Hexone				
Methyl isocyanate	624-83-9	0.02	0.05	X
Methyl isopropyl ketone	563-80-4			
Methyl mercaptan	74-93-1	(C)10	(C)20	
Methyl methacrylate	80-62-6	100	410	
Methyl parathion	298-00-0			
Methyl propyl ketone; see 2-Pentanone				
Methyl silicate	681-84-5			
alpha-Methyl styrene	98-83-9	(C)100	(C)480	
Methylene bisphenyl isocyanate (MDI)	101-68-8	(C)0.02	(C)0.2	
Metribuzin	21087-64-9			
Mica; see Silicates				
Molybdenum (as Mo)	7439-98-7			
Soluble compounds			5	
Insoluble compounds				
Total dust			15	
Monocrotophos (Azodrin®)	6923-22-4			
Monomethyl aniline	100-61-8	2	9	X
Morpholine	110-91-8	20	70	X
Naphtha (coal tar)	8030-30-6	100	400	
Naphthalene	91-20-3	10	50	
alpha-Naphthylamine; see 1910.1004	134-32-7			
beta-Naphthylamine; see 1910.1009	91-59-8			
Nickel carbonyl (as Ni)	13463-39-3	0.001	0.007	
Nickel, metal and insoluble compounds (as Ni)	7440-02-0		1	
Nickel, soluble compounds (as Ni)	7440-02-0		1	
Nicotine	54-11-5		0.5	X
Nitric acid	7697-37-2	2	5	
Nitric oxide	10102-43-9	25	30	
p-Nitroaniline	100-01-6	1	6	X
Nitrobenzene	98-95-3	1	5	X
p-Nitrochlorobenzene	100-00-5		1	X
4-Nitrodiphenyl; see 1910.1003	92-93-3			
Nitroethane	79-24-3	100	310	
Nitrogen dioxide	10102-44-0	(C)5	(C)9	
Nitrogen trifluoride	7783-54-2	10	29	
Nitroglycerin[1]	55-63-0	(C)0.2	(C)2	X
Nitromethane	75-52-5	100	250	
1-Nitropropane	108-03-2	25	90	
2-Nitropropane	79-46-9	25	90	
N-Nitrosodimethylamine; see 1910.1016	62-79-9			
Nitrotoluene		5	30	X
o-isomer	88-72-2			
m-isomer	99-08-1			
p-isomer	99-99-0			
Nitrotrichloromethane; see Chloropicrin				
Nonane	111-84-2		0.1	X
Octachloronaphthalene	2234-13-1			
Octane	111-65-9	500	2350	

TABLE Z-1 — Limits For Air Contaminants — Continued

Substance	CAS No. (c)	PEL[1] ppm (a)	PEL[1] mg/m³ (b)	Skin designation
Oil mist, mineral	8012-95-1		5	
Osmium tetroxide (as Os)	20816-12-0		0.002	
Oxalic acid	144-62-7		1	
Oxygen difluoride	7783-41-7	0.05	0.1	
Ozone	10028-15-6	0.1	0.2	
Paraffin wax fume	8002-74-2			
Paraquat, respirable dust	1910-42-5 4685-14-7 2074-50-2		0.5	X
Parathion	56-38-2		0.1	X
Particulates not otherwise regulated				
Total dust			15	
Respirable fraction			5	
Pentaborane	19624-22-7	0.005	0.01	
Pentachloronaphthalene	1321-64-8		0.5	X
Pentachlorophenol	87-86-5		0.5	X
Pentaerythritol	115-77-5			
Total dust			15	
Respirable fraction			5	
Pentane	109-66-0	1000	2950	
2-Pentanone (Methyl propyl ketone)	107-87-9	200	700	
Perchloromethylene (Tetrachloroethylene)	127-18-4	Tbl. Z-2		
NOTE: Stayed until 10/1/89 in the dry cleaning industry (FR 54: 36767, 9/5/89)				
Perchloromethyl mercaptan	594-42-3	0.1	0.8	
Perchloryl fluoride	7616-94-6	3	13.5	
Perlite				
Total dust			15	
Respirable fraction			5	
Petroleum distillates (Naphtha)(Rubber Solvent)		500	2000	
Phenol	108-95-2	5	19	X
Phenothiazine	92-84-2			
p-Phenylene diamine	106-50-3		0.1	X
Phenyl ether, vapor	101-84-8	1	7	
Phenyl ether-biphenyl mixture, vapor		1	7	
Phenylethylene; see Styrene				
Phenyl glycidyl ether (PGE)	122-60-1	10	60	
Phenylhydrazine	100-63-0	5	22	X
Phenyl mercaptan	108-98-5			
Phenylphosphine	638-21-1			
Phorate	298-02-2			
Phosdrin (Mevinphos[R])	7786-34-7		0.1	X
Phosgene (Carbonyl chloride)	75-44-5	0.1	0.4	
Phosphine	7803-51-2	0.3	0.4	
Phosphoric acid	7664-38-2		1	
Phosphorus (yellow)	7723-14-0		0.1	
Phosphorus oxychloride	10025-87-3			
Phosphorus pentachloride	10026-13-8		1	
Phosphorus pentasulfide	1314-80-3		1	
Phosphorus trichloride	7719-12-2	0.5	3	
Phthalic anhydride	85-44-9	2	12	
m-Phthalodinitrile	626-17-5			
Picloram	1918-02-1			
Total dust			15	
Respirable fraction			5	
Picric acid	88-89-1		0.1	X
Piperazine dihydro-chloride	142-64-3			
Pindone (2-Pivalyl-1,3-indandione)	83-26-1		0.1	
Plaster of Paris	26499-65-0			
Total dust			15	
Respirable fraction			5	
Platinum (as Pt)	7440-06-4			
Metal				
Soluble salts			0.002	
Portland cement	65997-15-1			
Total dust			Tbl. Z-3	
Respirable fraction			Tbl. Z-3	
Potassium hydroxide	1310-58-3			
Propane	74-98-6	1000	1800	
Propargyl alcohol	107-19-7			
beta-Propriolactone; see 1910.1013	57-57-8			
Propionic acid	79-09-4			
Propoxur (Baygon)	114-26-1			
n-Propyl acetate	109-60-4	200	840	
n-Propyl alcohol	71-23-8	200	500	
n-Propyl nitrate	627-13-4	25	110	
Propylene dichloride	78-87-5	75	350	
Propylene glycol dinitrate	6423-43-4			

TABLE Z-1 — Limits For Air Contaminants — Continued

Substance	CAS No. (c)	PEL[1] ppm (a)	PEL[1] mg/m³ (b)	Skin designation
Propylene glycol monomethyl ether	107-98-2			
Propylene imine	75-55-8	2	5	X
Propylene oxide	75-56-9	100	240	
Propyne; see Methyl acetylene				
Pyrethrum	8003-34-7		5	
Pyridine	110-86-1	5	15	
Quinone	106-51-4	0.1	0.4	
Resorcinol	108-46-3			
Rhodium (as Rh), metal fume and insoluble compounds	7440-16-6		0.1	
Rhodium (as Rh), soluble compounds	7440-16-6		0.001	
Ronnel	299-84-3		15	
Rosin core solder pyrolysis products, as formaldehyde				
Rotenone	83-79-4		5	
Rouge				
Total dust			15	
Respirable fraction			5	
Selenium compounds (as Se)	7782-49-2		0.2	
Selenium hexafluoride (as Se)	7783-79-1	0.05	0.4	
Silica, amorphous, precipitated and gel	112926-00-8		Tbl. Z-3	
Silica, amorphous, diatomaceous earth, containing less than 1% crystalline silica	61790-53-2		Tbl. Z-3	
Silica, crystalline cristobalite, respirable dust	14464-46-1		Tbl. Z-3	
Silica, crytalline quartz, respirable dust	14808-60-7		Tbl. Z-3	
Silica, crystalline tripoli (as quartz), respirable dust	1317-95-5		Tbl. Z-3	
Silica, crytalline tridymite, respirable dust	15468-32-2		Tbl. Z-3	
Silica, fused, respirable dust	60676-86-0		Tbl. Z-3	
Silicates (less than 1% crytalline silica)				
Mica (respirable dust)	12001-26-2		Tbl. Z-3	
Soapstone, total dust			Tbl. Z-3	
Soapstone, respirable dust			Tbl. Z-3	
Talc (containing asbestos): use asbestos limit			Tbl. Z-3	
See 29 CFR 1910.1001				
Talc (containing no asbestos), respirable dust	14807-96-6		Tbl. Z-3	
Tremolite			Tbl. Z-3	
See 29 CFR 1910.1101				
Silicon	7440-21-3			
Total dust			15	
Respirable fraction			5	
Silicon carbide	409-21-2			
Total dust			15	
Respirable fraction			5	
Silicon tetrahydride	7803-62-5			
Silver, metal and soluble compounds (as Ag)	7440-22-4		0.01	
Soapstone: see Silcates				
Sodium azide	26628-22-8			
(as HN_3)				
(as NaN_3)				
Sodium bisulfite	7631-90-5			
Sodium fluoroacetate	62-74-8		0.05	X
Sodium hydroxide	1310-73-2		2	
Sodium metabisulfite	7681-57-4			
Starch	9005-25-8			
Total dust			15	
Respirable fraction			5	
Stibine	7803-52-3	0.1	0.5	
Stoddard solvent	8052-41-3	500	2900	
Strychnine	57-24-9		0.15	
Styrene	100-42-5	Tbl. Z-2		
Subtilisins (Proteolytic enzymes)	9014-01-1			
Sucrose	57-50-1			
Total dust			15	
Respirable fraction			5	
Sulfur dioxide	7446-09-5	5	13	
Sulfur hexafluoride	2551-62-4	1000	6000	
Sulfuric acid	7664-93-9		1	
Sulfur monochloride	10025-67-9	1	6	
Sulfur pentafluoride	5714-22-7	0.025	0.25	
Sulfur tetrafluoride	7783-60-0			
Sulfuryl fluoride	2699-79-8	5	20	
Sulprofos	35400-43-2			
Systox[R], see Demeton				
2,4,5-T	93-76-5		10	
Talc: see Silicates				
Tantalum, metal and oxide dust	7440-25-7		5	
TEDP (Sulfotep)	3689-24-5		0.2	X
Tellurium and compounds (as Te)	13494-80-9		0.1	
Tellurium hexafluoride (as Te)	7783-80-4	0.02	0.2	

TABLE Z-1 — Limits For Air Contaminants — Continued

Substance	CAS No. (c)	PEL[1] ppm (a)	PEL[1] mg/m³ (b)	Skin designation
Temephos	3383-96-8			
Total dust			15	
Respirable fraction			5	
TEPP	107-49-3		0.05	X
Terphenyls	26140-60-3	(C)1	(C)9	
1,1,1,2-Tetrachloro-2,2-difluoroethane	76-11-9	500	4170	
1,1,2,2-Tetrachloro-1,2-difluoroethane	76-12-0	500	4170	
1,1,2,2-Tetrachloroethane	79-34-5	5	35	X
Tetrachoroethylene; see Perchloroethylene				
Tetrachloromethane, see Carbon tetrachloride				
Tetrachloronaphthalene	1335-88-2		2	X
Tetraethyl lead (as Pb)	78-00-2		0.075	X
Tetrahydrofuran	109-99-9	200	590	
Tetramethyl lead (as Pb)	75-74-1		0.075	X
Tetramethyl succinonitrile	3333-52-6	0.5	3	X
Tetranitromethane	509-14-8	1	8	
Tetrasodium pyrophosphate	7722-88-5			
Tetryl (2,4,6-Trinitrophenyl-methyl-nitramine)	479-45-8		1.5	X
Thallium, soluble compounds (as Tl)	7440-28-0		0.1	X
4,4'-Thiobis (6-tert, Butyl-m-cresol)	96-69-5			
Total dust			15	
Respirable fraction			5	
Thioglycolic acid	68-11-1			
Thionyl chloride	7719-09-7			
Thiram	137-26-8		5	
Tin, inorganic compounds (except oxides) (as Sn)	7440-31-5		2	
Tin, organic compounds (as Sn)	7440-31-5		0.1	
Tin oxide (as Sn)	21651-19-4			
Titanium dioxide	13463-67-7			
Total dust			15	
Toluene	108-88-3	Tbl. Z-2		
Toluene-2,4-diisocyanate (TDI)	584-84-9	(C)0.02	(C)0.14	
m-Toluidine	108-44-1			
o-Toluidine	95-53-4	5	22	X
p-Toluidine	106-49-0			
Toxaphene; see Chlorinated camphene				
Tremolite; see Silicates				
Tributyl phosphate	126-73-8		5	
Trichloroacetic acid	76-03-9			
1,2,4-Trichlorobenzene	120-82-1			
1,1,1,-Trichloroethane; see Methyl chloroform				
1,1,2-Trichloroethane	79-00-5	10	45	X
Trichloroethylene	79-01-6	Tbl. Z-2	Tbl. Z-2	Tbl. Z-2
Trichloromethane; see Chloroform				
Trichloronaphthalene	1321-65-9		5	X
1,2,3-Trichloropropane	96-18-4	50	300	
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	1000	7600	
Triethylamine	121-44-8	25	100	
Trifluorobromomethane	75-63-8	1000	6100	
Trimellitic anhydride	552-30-7			
Trimethylamine	75-50-3			
Trimethyl benzene	25551-13-7			
Trimethyl phosphite	121-45-9			
2,4,6-Trinitrophenyl; see Picric acid				
2,4,6-Trinitrophenylmethyl nitramine; see Tetryl				
2,4,6-Trinitrotoluene (TNT)	118-96-7		1.5	X
Triorthocresyl phosphate	78-30-8		0.1	
Triphenyl amine	603-34-9			
Triphenyl phosphate	115-86-6		3	
Tungsten (as W)	7440-33-7			
Insoluble compounds				
Soluble compounds				
Turpentine	8006-64-2	100	560	
Uranium (as U)	744-61-1			
Soluble compounds			0.05	
Insoluble compounds			0.25	
n-Valeraldehyde	110-62-3			
Vanadium	1314-62-1			
Respirable dust (as V_2O_3)			(C)0.5	
Fume (as V_2O_3)			(C)0.1	
Vegetable oil mist				
Total dust			15	
Respirable fraction			5	
Vinyl acetate	108-05-4			
Vinyl benzene; see Styrene				
Vinyl bromide	593-60-2			
Vinyl chloride; see 1910.1017	75-01-4			
Vinyl cyanide; see Acrylonitrile				
Vinyl cyclohexene dioxide	106-87-6			

TABLE Z-1 — Limits for Air Contaminants — Continued

Substance	CAS No. (c)	PEL[1] ppm (a)	PEL[1] mg/m³ (b)	Skin designation
Vinylidene chloride (1,1-Dichloroethylene)	75-35-4			
Vinyl toluene	25013-15-4	100	480	
VM & P Naphtha	8032-32-4			
Warfarin	81-81-2		0.1	
Welding fumes (total particulate)***				
Wood dust, all soft and hard woods, except Western red cedar				
Wood dust, Western red cedar				
Xylenes (o-, m-, p-, isomers)	1330-20-7	100	435	
m-Xylene alpha, alpha'- diamine	1477-55-0			
Xylidine	1300-73-8	5	25	X
Yttrium	7440-65-5		1	
Zinc chloride fume	7646-85-7		1	
Zinc chromate (as CrO_3)	Varies with compound	Tbl. Z-2	Tbl. Z-2	Tbl. Z-2
Zinc oxide fume	1314-13-2		5	
Zinc oxide	1314-13-2			
Total dust			15	
Respirable fraction			5	
Zinc stearate	577-05-1			
Total dust			15	
Respirable fraction			5	
Zirconium compounds (as Zr)	7440-67-7		5	

* The transitional PELs are 8-hour TWAs unless otherwise noted; a (C) designation denotes a ceiling limit.

** Unless otherwise noted, employers in General Industry (i.e., those covered by 29 CFR 1910) may use any combination of controls to achieve these limits until Dec. 31, 1993 as set forth in 29 CFR 1910.1000(f).

*** As determined from breathing-zone air samples.

1) The PELs are 8-hour TWAs unless otherwise noted; a (C) designation denotes a ceiling limit. They are to be determined from breathing-zone air samples.

(a) Parts of vapor or gas per million parts of contaminated air by volume at 25 degrees C and 760 torr.

(b) Milligrams of substance per cubic meter of air. When entry is in this column only, the value is exact; when listed with a ppm entry, it is approximate.

(c) The CAS number is for information only. Enforcement is based on the substance name. For an entry covering more than one metal compound, measured as the metal, the CAS number for the metal is given - not CAS numbers for the individual compounds.

(d) The final benzene standard in 1910.1028 applies to all occupational exposures to benzene except in some circumstances the distribution and sale of fuels, sealed containers and pipelines, coke production, oil and gas drilling and production, natural gas processing, and the percentage exclusion for liquid mixtures; for the excepted subsegments, the benzene limits in Table Z-2 apply. See 1910.1028 for specific circumstances.

(e) This 8-hour TWA applies to respirable dust as measured by a vertical elutriator cotton dust sampler or equivalent instrument. The time-weighted average applies to the cottom waste processing operations of waste recycling (sorting, blending, cleaning and willowing) and garnetting. See also 1910.1043 for cotton dust limits applicable to other sectors.

(f) All inert or nuisance dusts, whether mineral, inorganic, or organic, not listed specifically by substance name are covered by the Particulates Not Otherwise Regulated (PNOR) limit which is the same as the inert or nuisance dust limit of Table Z-3.

2) See Table Z-2

3) See Table Z-3

4) Varies with compound.

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TABLE Z-2

Material	8-hour time weighted average	Acceptable ceiling concentration	Acceptable maximum peak above the acceptable ceiling concentration for an 8-hour shift	
			Concentration	Maximum duration
Benzene (Z37.4-1969)[1]	10 ppm	25 ppm	50 ppm	10 minutes
Beryllium and beryllium compounds (Z37.29-1970)	2μg/M³	5μg/M³	25μg/M³	30 minutes
Cadmium dust (Z37.5-1970)[3]	0.2 mg/M³	0.6 mg/M³		
Cadmium fume (Z37.5-1970)[3]	0.1 mg/M³	0.3 mg/M³		
Carbon disulfide (Z37.3-1968)	20 ppm	30 ppm	100 ppm	30 minutes
Carbon tetrachloride (Z37.17-1967)	10 ppm	25 ppm	200 ppm	5 minutes in any 4 hours
Chromic acid and chromates (Z37.7-1971)	1 mg/10M³			
Ethylene dibromide (Z37.31-1970)	20 ppm	30 ppm	50 ppm	5 minutes
Ethylene dichloride (Z37.21-1969)	50 ppm	100 ppm	200 ppm	5 minutes in any 3 hours
Fluoride as dust (Z37.28-1969)	2.5 mg/M³			
Formaldehyde (Z37.16-1967)[2]	3 ppm	5 ppm	10 ppm	30 minutes
Hydrogen fluoride (Z37.28-1969)	3 ppm			
Hydrogen sulfide (Z37.2-1966)		20 ppm	50 ppm	10 minutes once only if no other measurable exposure occurs
Mercury (Z37.8-1971)		1 mg/10M³		
Methyl chloride (Z37.18-1969)	100 ppm	200 ppm	300 ppm	5 minutes in any 3 hours
Methylene chloride (Z37.3-1969)	500 ppm	1,000 ppm	2,000 ppm	5 minutes in any 2 hours
Organo (alkyl) mercury (Z37.30-1969)	0.01 mg/M³	0.04 mg/M³		
Styrene (Z37.15-1969)	100 ppm	200 ppm	600 ppm	5 minutes in any 3 hours
Tetrachloroethylene (Z37.22-1967)	100 ppm	200 ppm	300 ppm	5 minutes in any 3 hours
Toluene (Z37.12-1967)	200 ppm	300 ppm	500 ppm	10 minutes
Trichloroethylene (Z37.19-1967)	100 ppm	200 ppm	300 ppm	5 minutes in any 2 hours

[1]This standard applies to the industry segments exempt from the 1 ppm 8-hour TWA and 5 ppm STEL of the benzene standard at 1910.1028. This standard also applies to any industry for which 1910.1028 is stayed or otherwise not in effect.

[2]This standard applies to any industry for which 1910.1048 is stayed or otherwise not in effect.

[3]This standard applies to any operations or sectors for which 1910.1027 is stayed or otherwise not in effect.

TABLE Z-3–Mineral Dusts

Substance	Mppcf[e]	mg/m³
SILICA:		
CRYSTALLINE		
QUARTZ (RESPIRABLE)	250[f]	10 MG/m³[m]
QUARTZ (TOTAL DUST)	$\%SiO_2 + 5$	$\%SiO_2 + 2$ 30 mg/m³
CRISTOBALITE: Use ½ the value calculated from the count or mass formulas for quartz		
TRIDYMITE: Use ½ the value calculated from the formulae for quartz		
AMORPHOUS, including natural diatomaceous earth	20	80 mg/m³
		$\%SiO_2$
SILICATES (less than 1% crystalline silica):		
Mica	20	.....
Soapstone	20	.....
Talc (not containing asbestos)	20[n]	
Talc (containing asbestos). Use asbestos limit	50	.....
Tremolite (see 29 CFR 1910.1101)		
Portland cement		
GRAPHITE (NATURAL)	15	.....
COAL DUST (respirable fraction less than 5% SiO_2)		2.4 mg/m³ or
For more than 5% SiO_2		10 mg/m³
		$\%SiO_2 + 2$
INERT OR NUISANCE DUST:[g]		
Respirable fraction	15	5 mg/m³
Total dust	50	15 mg/m³

Note: Conversion Fractors — mppcf × 35.3 = million particles per cubic meter = particles per c.c.

[e]Millions of particles per cubic foot of air, based on impinger samples counted by light-field techniques.

[f]The percentage of crystalline silica in the formula is the amount determined from airborne samples, except in those instances in which other methods have been shown to be applicable.

[g]All inert or nuisance dusts, whether mineral, inorganic, or organic, not listed specifically by substance name, are covered by the Particulates Not Otherwise Regulated (PNOR) limit in Table Z-1-A.

[m]Both concentration and percent quartz for the application of this limit are to be determined from the fraction passing a size-selector with the following characteristics:

Aerodynamic diameter (unit density sphere)	Percent passing selector
2	90
2.5	75
3.5	50
5.0	25
10	0

[n]Containing less than 1% quartz; if 1% quartz, use quartz limit.

The measurements under this note refer to the use of an AEC (now NRC) instrument. The respirable fraction of coal dust is determined with an MRE; the figure corresponding to that of 2.4 mg/m³ in the table for coal dust is 4.5 mg/m³.

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1910.1001 — ASBESTOS

	YES	NO

(a) Scope and Application

This section applies to all occupational exposures to asbestos in workplaces covered by OSHA, except for construction, which is covered by 1926.58.

(b) Definitions

See page Z-iii

(c) Permissible Exposure Limit

Is employee exposure over an eight hour day limited to not more than 0.2 fibers per cubic centimeter (f/cc) of air? **(c)(1)**

(d) Exposure Monitoring

Have representative samples of average daily exposure been taken from the employees' breathing zone? **(d)(1)(i)**

Have exposures been determined based on one or more samples representing full shift exposures:

for each shift?

for each employee?

in each job classification?

in each work area? **(d)(1)(ii)**

Has initial monitoring of employees exposed to airborne concentrations above 0.1 f/cc (the action level) been conducted? **(d)(2)(i)**

Monitoring conducted after December 20, 1985 that meets the requirements of this section may be used to satisfy the initial monitoring requirements. **(d)(2)(ii)**

No initial monitoring is required if the employer can prove that asbestos cannot be released in airborne concentrations at or above the action level under the normal use and handling. **(d)(2)(iii)**

Is periodic monitoring conducted at reasonable intervals in order to accurately represent employee exposure levels?

For employees whose exposure exceeds the action level, is sampling conducted at least every six months? **(d)(3)**

If initial or periodic monitoring shows employee exposures below the action level, monitoring may be discontinued. **(d)(4)**

If there has been a change in production, process, control equipment, personnel or work practices that may result in new or additional exposures above the action level, is new exposure monitoring conducted? **(d)(5)**

Do sample collection procedures match or are they equivalent to the OSHA Reference Method specified in Appendix A? **(d)(6)(i-ii)**

If an equivalent method is used:

Is equivalency established by data collected side-by-side in field and laboratory comparisons?

Does the comparison indicate that 90% of the samples collected (from 0.1 to 0.4 f/cc) have an accuracy range of ±25% of the ORM with a 95% confidence level?

Is the comparison documented and the results of comparison testing maintained? **(d)(6)(iii)**

Are monitoring analyses performed by laboratories whose quality assurance programs meet the requirements of Appendix A? **(d)(6)(iv)**

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Are employees notified (either in writing or by posting) of monitoring results within 15 days after the receipt of results? **(d)(7)(i)**

When results indicate that the permissible exposure limit was exceeded, does the written notification include a description of the corrective action being taken to reduce employee exposure? **(d)(7)(ii)**

(e) Regulated Areas

Wherever exposures are above the PEL, are regulated areas established? **(e)(1)**

Are the regulated areas demarcated from the rest of the workplace to minimize employee exposure? **(e)(2)**

Is access to regulated areas limited to authorized persons? **(e)(3)**

Is everyone who enters a regulated area provided with and required to wear an appropriate respirator as specified in (g)(2) below? **(e)(4)**

Are employees prohibited from eating, drinking, smoking, chewing tobacco or gum, or applying cosmetics in regulated areas? **(e)(5)**

(f) Methods of Compliance

Have feasible engineering controls and work practices been instituted to minimize employee exposure? Where these controls are insufficient to reduce exposures to the PEL, are they at least used to reduce exposure to the lowest levels achievable and then supplemented by respiratory protection? **(f)(1)(i-ii)**

For the following operations when the PEL cannot be achieved, are engineering and work practice controls used to reduce employee exposure to or below 0.5 f/cc, with respiratory and other protection used to reduce exposures below the PEL:

coupling cutoff in primary asbestos cement pipe manufacturing;

sanding in primary and secondary friction product manufacturing;

carding and spinning in dry textile processes; and grinding and sanding in primary plastics manufacturing? **(f)(1)(iii)**

Are local exhaust ventilation and dust collection systems designed, constructed, installed, and maintained in accordance with good practices such as those outlined in the American National Standard Fundamentals Governing the Design and Operation of Local Exhaust Systems (ANSI Z9.2-1979)? **(f)(1)(iv)**

Is local exhaust ventilation provided for all hand-operated and power operated tools which might release fibers in excess of the permissible exposure limit? **(f)(1)(v)**

When practicable, is asbestos worked in a wet state sufficient to prevent the release of airborne fibers in excess of the PEL? **(f)(1)(vi)**

[Reserved] **(f)(1)(vii)**

When being removed from shipping containers, are materials containing asbestos (such as asbestos cement, mortar, coating, grout, plaster, etc.) wetted, enclosed, or ventilated to prevent the release of fibers above the PEL? **(f)(1)(viii)**

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YES	NO

Is compressed air never used to remove asbestos or materials containing these minerals unless the compressed air is used in conjunction with an appropriate ventilation system which will capture the dust cloud produced by the compressed air? **(f)(1)(ix)**

Where the PEL is exceeded, is a written program to reduce employee exposure by means of work practice and engineering controls and respiratory protection established and implemented? Is the written program reviewed and updated as necessary? **(f)(2)(i-ii)**

Upon request, the written program will be submitted for examination and copying to OSHA officials, affected employees, and designated employee representatives. **(f)(2)(iii)**

Employee rotation is not used as a means of compliance with the permissible exposure limit. **(f)(2)(iv)**

(g) Respiratory Protection

Respirators are provided and their use ensured:

during the time necessary to implement work practice and/or engineering controls;

in work operations such as maintenance and repair activities where engineering and work practice controls are not feasible;

in situations where feasible engineering and work practice controls ae not yet sufficient to reduce exposure to or below the PEL; and during emergencies. **(g)(1)**

When respirators are required is the appropriate respirator provided at no cost to the employee? Are respirators selected according to Table 1 and are they approved by MSHA and NIOSH? **(g)(2)(i)**

TABLE 1 — Respiratory Protection for Asbestos

Airborne concentration of asbestos	Required respirator
Not in excess of 2 f/cc (10 x PEL)	1. Half mask air purifying respirator equipped with high-efficiency filters
Not in excess of 10 f/cc (50 x PEL)	1. Full facepiece air purifying respirator equipped with high efficiency filters
Not in excess of 20 f/cc (50 x PEL)	1. Any powered air purifying respirator equipped with high efficiency filters 2. Any supplied air respirator operated in continuous flow mode
Not in excess of 200 f/cc (1000 x PEL)	1. Full facepiece supplied air respirator operated in pressure demand mode
Greater than 200 f/cc (100 x PEL or unknown concentration)	1. Full facepiece supplied air respirator operated in pressure demand mode equipped with an auxiliary positive pressure self contained breathing apparatus

Notes: a. Respirators assigned for higher environmental concentrations may be used at lower concentrations.

b. A high efficiency filter means a filter that is at least 99.97% efficient against mono-dispersed particles of 0.3 micromenters or larger.

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Is a powered, air purifying respirator provided instead of a negative pressure respirator whenever an employee requests this type of respirator; or the respirator will provide adequate protection to the employee? **(g)(2)(ii)**

If respiratory protection is required, is a respirator program meeting the requirements of 1910.134 (b),(d),(e), and (f)(Subpart I) established and implemented? **(g)(3)(i)**

Whenever an increase in breathing resistance is detected in a filter respirator, is the filter element changed? **(g)(3)(ii)**

Are employees who wear respirators permitted to leave the regulated area to wash their faces and respirator facepieces whenever necessary to prevent skin irritation? **(g)(3)(iii)**

If a physician determines that an employee is unable to function normally wearing a respirator, or that the safety or health of the employee would be impaired, the employee is not required to wear a respirator and is assigned to another job or given the opportunity to transfer to a different, but comparable, position in the company if such a position is available. This employee does not lose seniority, status, or rate of pay. **(g)(3)(iv)**

Are respirators issued to employees fitted properly and do they exhibit the least possible facepiece leakage? **(g)(4)(i)**

Are quantitative or qualitative face fit tests of negative pressure respirators conducted at the time of initial fitting and at least every six months thereafter? Are qualitative fit tests used for half mask respirators only? **(g)(4)(ii)**

(h) Protective Work Clothing and Equipment

When employees are exposed to asbestos above the PEL, or where the possibility of eye irritation exists, is protective work clothing and equipment provided at no cost to the employee? Does this clothing include:

coveralls or similar full-body work clothing;

gloves, head coverings, and foot coverings; and

face shields, vented goggles, or other protective equipment complying with Subpart I, section 1910.133? **(h)(1)**

Do employees remove contaminated work clothing only in the change rooms provided? **(h)(2)(i)**

Employees do not remove contaminated clothing from the change rooms, except those employees involved with laundering, maintenance, or disposal. **(h)(2)(ii)**

Is contaminated work clothing placed and stored in closed containers? Are these containers labeled before being removed from the change rooms or the workplace? **(h)(2)(iii-iv)**

Is protective clothing cleaned, laundered, repaired, and replaced when necessary to maintain its effectiveness? Is clean protective clothing and equipment provided at least weekly to each employee? Is blowing or shaking of clothing for dust removal prohibited, and is laundering done so as to prevent the release of fibers in excess of the PEL? **(h)(3)(i-iii)**

Are launderers informed of the requirements to prevent the release of fibers during laundering of contaminated clothing? Are they also informed of the hazards of exposure to asbestos? **(h)(3)(iv-v)**

Is contaminated clothing transported in sealed impermeable bags or other closed, impermeable containers and labeled in accordance with Subpart J? **(h)(3)(vi)**

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(i) Hygiene Facilities and Practices		
Are clean change rooms provided for employees exposed to asbestos above the permissible exposure limit? Do change rooms meet the requirements of 1910.141(e) in Subpart J and are they equipped with two separate lockers or storage areas to prevent cross contamination of clothing? **(i)(1)**		
Do employees whose exposure is above the permissible exposure limit shower at the end of the work shift? Do shower facilities meet the requirements of 1910.141(d)(3) in Subpart J?		
After showering, do employees not leave the workplace wearing any clothing or equipment worn during the work shift? **(i)(2)**		
Are lunchroom facilities provided for employees whose exposure is above the PEL?		
Do lunchrooms have a positive pressure, filtered air supply and are they readily accessible to employees?		
Do employees wash their hands and faces before eating, drinking, or smoking?		
Employees do not enter these lunchrooms wearing protective work clothing or equipment unless surface asbestos dust has been removed by vacuuming or other method. **(i)(3)**		
(j) Communication of Hazards to Employees		
Are warning signs displayed at each regulated area, and at all approaches to regulated areas so that employees may take the necessary steps before entering the area? **(j)(1)(i)**		
Do warning signs contain the following information: DANGER ASBESTOS CANCER AND LUNG DISEASE HAZARD AUTHORIZED PERSONNEL ONLY RESPIRATORS AND PROTECTIVE CLOTHING ARE REQUIRED IN THIS AREA		
Are warning labels affixed to all raw materials, mixtures, scrap, waste, debris, and other products containing asbestos or affixed to their containers? **(j)(2)(i)**		
Do labels comply with the requirements of 1910.1200(f), the hazard communication standard, and include the following information: DANGER CONTAINS ASBESTOS FIBERS AVOID CREATING DUST CANCER AND LUNG DISEASE HAZARD		
As a manufacturer or importer of asbestos, or products containing asbestos, do you maintain material safety data sheets as specified in 1910.1200(g) of the hazard communication standard, except where: asbestos fibers have been modified by a bonding agent, coating, binder, or other material when no airborne concentrations above the PEL will be released during foreseeable use; or asbestos is present in a product in concentrations less than 0.1%? **(j)(3-4)**		

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Has a training program for all employees exposed above the PEL been instituted and employee participation been ensured? **(j)(5)(i)**		
Is training provided upon initial assignment and at least annually thereafter? **(j)(5)(ii)**		
Are employees able to understand the training clearly and are they informed of: the health effects associated with asbestos exposure; the relationship between smoking and exposure to asbestos, in producing lung cancer; the quantity, location, manner of use, release, and storage of asbestos and the specific nature of operations which could result in exposure to these substances; the specific procedures used to protect employees from exposure such as appropriate work practices, emergency and cleanup procedures, and personal protective equipment; the purpose, proper use, and limitations of respirators and protective clothing; the purpose and a description of the medical surveillance program required; this standard and its appendices? **(j)(5)(iii)** the names, addresses, and phone numbers of public health organizations which provide information, materials, and programs on smoking cessation; and the requirement for posting signs and affixing labels and the meaning of the required legends for such signs and labels.		
Is a copy of this standard and its appendices available to affected employees without cost? Are materials relating to the employee information and training program available to OSHA and NIOSH officials? **(j)(5)(iv)(A-B)**		
Have employees been informed of the availability of self-help smoking cessation program materials? Are employees provided, upon request, NIH Publication No. 89-1647? **(j)(5)(iv)(C)**		
(k) Housekeeping		
As much as possible, are surfaces maintained as free of dust and waste containing asbestos? **(k)(1)**		
Are spills of material containing asbestos cleaned up as soon as possible? **(k)(2)**		
Compressed air is not used to clean surfaces contaminated with asbestos. **(k)(3)**		
Is HEPA-filtered vacuuming equipment used for vacuuming? Is it used and emptied in a way that minimizes the release of asbestos? **(k)(4)**		
Is shoveling, dry sweeping, and dry clean-up of asbestos, used only where vacuuming and/or wet cleaning are not feasible? **(k)(5)**		
Are waste, scrap, debris, bags, containers, equipment, and clothing contaminated with asbestos collected and disposed of in sealed, impermeable bags or other closed impermeable containers? **(k)(6)**		

YES | NO

(l) Medical Surveillance

Has a medical surveillance program for all affected employees been instituted?

Are all medical examinations and procedures performed by or under the supervision of a licensed physician and provided to the employee at no cost and at a reasonable time and place?

Have those persons other than licensed physicians who administer the pulmonary function testing required completed a course in spirometry approved by an academic or professional institution? **(l)(1)(i-ii)**

Are preplacement examinations provided for employees before they are assigned to an occupation involving exposure to asbestos? **(l)(2)(i)**

Do these examinations include:

a medical and work history;

a complete physical examination with emphasis on the respiratory system, the cardiovascular system and digestive tract;

completion of the questionnaire in Appendix D, Part 1 on respiratory disease;

a chest X-ray;

pulmonary function tests including forced vital capacity and forced expiratory volume at one second (FEV1.0); and

any additional tests the physician deems appropriate?

Interpretations of the chest X-rays are conducted in accordance with Appendix E. **(l)(2)(ii)**

Are periodic medical examinations made available annually? **(l)(3)(i)**

Do these periodic examinations conform to the protocol above, except with chest X-rays conducted in accordance with Table 2 and the abbreviated standardized questionnaire found in Appendix D, Part 2. **(l)(3)(ii)**

TABLE 2 — Frequency of Chest Roentgenograms

Years since first exposure	Age of employee 15-35	35-45	45 +
0-10	Every 5 yrs	Every 5 yrs	Every 5 yrs
10 +	Every 5 yrs	Every 5 yrs	Every 5 yrs

Is a termination of employment medical examination provided for any employee who has been exposed to asbestos above the action level? **(l)(4)(i)**

Is this examination conducted in accordance with the periodic examination requirements and given within 30 calendar days (before or after) the termination of employment? **(l)(4)(ii)**

If adequate records show that an employee has been examined in accordance with any of the above requirements within the last year, no medical examination is necessary. **(l)(5)**

Is the following information provided to the examining physician:

a copy of this standard and Appendices D and E;
a description of the employee's duties as they relate to exposure;

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the employee's representative or anticipated exposure level;

a description of any personal protective and respiratory equipment used or to be used; and

information from previous medical examinations not otherwise available to the examining physician? **(l)(6)**

Has the physician provided a written signed opinion from the examining physician which contains the results of the medical examination and includes: **(l)(7)(i)**

the physician's opinion as to whether the employee has any detected medical conditions that would place the employee at an increase health risk from exposure to asbestos;

any recommended limitations on the employee or upon the use of personal protective equipment;

a statement that the employee has been informed of the results of the medical examination and any medical conditions resulting from exposure to asbestos that require further explanation or treatment; and

a statement that the employee has been informed of the increased risk of lung cancer attributable to the combined effect of smoking and asbestos esposure? **(l)(7)(i)(A-D)**

Has the physician been instructed not to reveal in the written opinion any findings unrelated to occupational exposure to asbestos? **(l)(7)(ii)**

Is a copy of the physician's written opinion provided to the employee within 30 days of its receipt? **(l)(7)(iii)**

(m) Recordkeeping

Is an accurate record of all measurements taken to monitor employee exposure to asbestos kept, and does it include the following information:

the date of measurement;

the operation which is being monitored;

sampling and analytical methods used and evidence of their accuracy;

number, duration, and results of samples taken;

type of respiratory protective devices worn, if any; and

name, social security number, and exposure of the employees whose exposures are represented?

Is this record maintained for at least 30 years? **(m)(1)**

When operations are exempt from other requirements of this section [see paragraph (d)(2)(iii)], are accurate records maintained which document the data relied upon for the exemption? Do these records include:

the product/operation qualifying for exemption;

the source of the objective data;

the testing protocol, results of testing, and/or analysis of the material for the release of asbestos;

a description of the operation exempted and how the data support the exemption; and

other data relevant to the operations, materials, processing, or employee exposures covered by the exemption?

Is this record maintained for as long as it is relied upon for exemption status? **(m)(2)**

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Is an accurate record for each employee subject to medical surveillance maintained, and does it include:		
the name and social security number of the employee;		
the physician's written opinions;		
any employee medical complaints related to exposure; and		
a copy of the information provided to the physician under paragraph (l)(6) of this section?		
Is this record maintained for the duration of employment plus 30 years? **(m)(3)**		
Are all employee training records maintained for one year beyond the last date of employment of the employee? **(m)(4)**		
Upon written request, are all records required by this section available to OSHA and NIOSH officials for examination and copying? **(m)(5)(i)**		
Upon request, are any exposure records required by paragraph (m)(1) available for examination and copying to affected employees, former employees, designated employee representatives, and the Assistant Secretary? **(m)(5)(ii)**		
Upon request, are employee medical records required in paragraph (m)(2) available for examination and copying to the affected employee, anyone having the written consent of the employee, and the Assistant Secretary? **(m)(5)(iii)**		
Is the transfer of records in compliance with the requirements of 1910.20(h)? **(m)(6)(i)**		
Whenever the employer ceases to do business and there is no successor employer to receive and retain records, is the Director (of NIOSH) notified at least 90 days prior to disposal of records, and upon request, will the records be transmitted to the Director? **(m)(6)(ii)**		
(n) Observation of Monitoring		
Do employees and their designated representatives have the opportunity to observe monitoring of employee exposure? Are observers provided with and required to use protective clothing and equipment and comply with all other safety and health procedures when entering an area where such protection is necessary? **(n)**		
(o) Effective Date		
Effective date: July 21, 1986		
All obligations of this standard commence on the effective date except as follows:		
AS SOON AS POSSIBLE BUT NO LATER THAN:		
October 20, 1986		
Initial monitoring required by paragraph (d)(2).		
Employee information and training required by paragraph (j)(5).		

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	YES	NO
November 17, 1986		
Regulated areas required by paragraph (e) established.		
Respiratory protection for employees whose TWA exposure exceeds the PEL but is less than 2 f/cc.		
Medical examinations required by paragraph (l).		
January 16, 1987		
Powered air-purifying respirators provided for under paragraph (g)(2)(ii).		
Construction plans for change rooms, showers, lavatories, and lunchroom facilities.		
July 20, 1987		
Change rooms, showers, lavatories, and lunchroom facilities constructed and in use.		
Written compliance programs required by paragraph (f)(2) completed and available.		
July 20, 1988		
Engineering and work practice controls implemented. **(o)**		
Note: Respiratory protection for employees whose TWA exposure is above the PEL and exceeds 2 f/cc is required effective July 21, 1986.		
Appendices A, C, D, and E, are incorporated and the contents are mandatory. Appendices B, F, G, and H are informational and not intended to create any additional obligations not otherwise imposed or to detract from existing obligations. The appendices begin on page Z-App-9. **(p)**		

1910.1002 — COAL TAR PITCH VOLATILES

	YES	NO
Interpretation of Term		
Are you aware that coal tar pitch volatiles include the fused polycyclic hydrocarbons which volatilize from the distillation residues of coal, petroleum (excluding asphalt), wood, and other organic matter? See Table Z-1* for exposure limits.		

†1910.1003 — 4-NITROBIPHENYL

	YES	NO
If you manufacture, process, repackage, release, handle, or store 4-Nitrobiphenyl, Chemical Abstracts Service Registry Number 92933, this entire section applies. This section does not apply to the transshipment in sealed containers, except for the labeling requirements under paragraphs (e)(2), (3) and (4), Sec. 1910.1003. **(a)(1)**		
This section does not apply to soiled or liquid mixtures containing less than 0.1 percent by weight or volume of 4-Nitrobiphenyl. **(a)(2)**		
NOTE: All of the requirements of Sec. 1910.1003(b) through 1910.1003(g)(2)(iii) are incorporated in a "checklist" which follows Sec. 1910.1006. **(a(2)**		

YES | NO

† 1910.1004 – ALPHA-NAPHTHYLAMINE

If you manufacture, process, repackage, release, handle, or store alpha-Naphthylamine, Chemical Abstracts Service Registry Number 134327, this entire section applies. This section does not apply to the transshipment in sealed containers, except for the labeling requirements under paragraphs (e)(2), (3), and (4), Sec. 1910.1003. (See Checklist). (a)(1)

This section does not apply to solid or liquid mixtures containing less than 1.0 percent by weight or volume of alpha-Naphthylamine. (a)(2)

This section does not apply to operations involving the destructive distillation of carbonaceous materials, such as occurs in coke ovens. (a)(3)

NOTE: All of the requirements of Section 1910.1004(b) through 1910.1004(g)(2)(iii) are incorporated in a "Checklist" which follows Sec. 1910.1016. (a)(3)

1910.1005 – 4,4'-METHYLENE BIS (2-Chloroaniline)

As of August 16, 1976 OSHA has deleted all standards applying to this chemical.

† 1910.1006 – METHYL CHLOROMETHYL ETHER

If you manufacture, process, repackage, release, handle, or store methyl chloromethyl ether, Chemical Abstracts Service Registry Number 107302, this entire section applies. This section does not apply to the transshipment in sealed containers, except for the labeling requirements under paragraphs (e)(2), (3), and (4), Sec. 1910.1003. (See Checklist). (a)(1)

This section does not apply to solid or liquid mixtures containing less than 0.1 percent by weight or volume of methyl chloromethyl ether. (a)(2)

NOTE: All of the requirements of Section 1910.1006(b) through 1910.1006(g)(2)(iii) are incorporated in a "Checklist" which follows Sec. 1910.1016. (a)(2)

YES | NO

† 1910.1007 – 3,3'-DICHLOROBENZIDINE (and its Salts)

If you manufacture, process, repackage, release, handle, or store 3,3'-Dichlorobenzidine (or its salts), Chemical Abstracts Service Registry Number 91941, this entire section applies. This section does not apply to the transshipment in sealed containers, except for the labeling requirements under paragraphs (e)(2), (3), and (4), Sec. 1910.1003. (See Checklist). (a)(1)

This section does not apply to solid or liquid mixtures containing less than 1 percent by weight or volume of 3,3'-Dichlorobenzidine (or its salts). (a)(2)

NOTE: All of the requirements of Sec. 1910.1007(b) through 1910.1007(g)(2)(iii) are incorporated in a "Checklist" which follows Sec. 1910.1016. (a)(2)

1910.1008 – BIS-CHLOROMETHYL ETHER

If you manufacture, process, repackage, release, handle, or store bis-Chloromethyl ether, Chemical Abstracts Service Registry Number 542881, this entire section applies. (a)(1)

This section does not apply to the transshipment in sealed containers, except for the labeling requirements under paragraphs (e)(2), (3), and (4), Sec. 1910.1003. (See Checklist). (a)(1)

This section does not apply to solid or liquid mixtures containing less than 0.1 percent by weight or volume of bis-Chloromethyl ether. (a)(2)

NOTE: All of the requirements of Sec. 1910.1008(b) through 1910.1008(g)(2)(iii) are incorporated in a "Checklist" which follows Sec. 1910.1016. (a)(2)

	YES	NO
1910.1009 – BETA-NAPHTHYLAMINE If you manufacture, process, repackage, release, handle, or store beta-Naphthylamine, Chemical Abstracts Service Registry Number 91598, this entire section applies. This section does not apply to the transshipment in sealed containers, except for the labeling requirements under paragraphs (e)(2), (3), and (4), Sec. 1910.1003. (See Checklist). **(a)(1)** This section does not apply to solid or liquid mixtures containing less than 0.1 percent by weight or volume of beta-Naphthylamine. **(a)(2)** This section does not apply to operations involving the destructive distillation of carbonaceous materials, such as occurs in coke ovens. **(a)(3)** NOTE: All of the requirements of Section 1910.1009(b) through 1910.1009(g)(2)(iii) are incorporated in a "Checklist" which follows Sec. 1910.1016. **(a)(3)**		
† **1910.1010 – BENZIDINE** If you manufacture, process, repackage, release, handle, or store Benzidine, Chemical Abstracts Service Registry Number 92875, this entire section applies. This section does not apply to the transshipment in sealed containers, except for the labeling requirements under paragraphs (e)(2), (3), and (4), Sec. 1910.1003. (See Checklist). **(a)(1)** This section does not apply to solid or liquid mixtures containing less than 0.1 percent by weight or volume of Benzidine. **(a)(2)** NOTE: All of the requirements of Sec. 1910.1010(b) through 1910.1010(g)(2)(iii) are incorporated in a "Checklist" which follows Sec. 1910.1016. **(a)(2)**		
† **1910.1011 – 4-AMINODIPHENYL** If you manufacture, process, repackage, release, handle, or store 4-Aminodiphenyl, Chemical Abstracts Service Registry Number 92671, this entire section applies. This section does not apply to the transshipment in sealed containers, except for the labeling requirements under paragraphs (e)(2), (3), and (4), Sec. 1910.1003. (See Checklist). **(a)(1)** This section does not apply to solid or liquid mixtures containing less than 0.1 percent by weight or volume of 4-Aminodiphenyl. **(a)(2)** NOTE: All of the requirements of Sec. 1910.1011(b) through 1910.1011(g)(2)(iii) are incorporated in a "Checklist" which follows Section 1910.1016.		

	YES	NO
† **1910.1012 – ETHYLENEIMINE** If you manufacture, process, repackage, release, handle, or store Ethyleneimine, Chemical Abstracts Service Registry Number 151564, this entire section applies. **(a)(1)** This section does not apply to the transshipment in sealed containers, except for the labeling requirements under paragraphs (e)(2), (3), and (4), Sec. 1910.1003. (See Checklist). **(a)(1)** This section does not apply to solid or liquid mixtures containing less than 1.0 percent by weight or volume of Ethyleneimine. **(a)(2)** NOTE: All of the requirements of Section 1910.1012(b) through 1910.1012(g)(2)(iii) are incorporated in a "Checklist" which follows Sec. 1910.1016.		
† **1910.1013 – BETA-PROPIOLACTONE** If you manufacture, process, repackage, release, handle, or store beta-Propiolactone, Chemical Abstracts Service Registry Number 57578, this entire section applies. This section does not apply to the transshipment in sealed containers, except for the labeling requirements under paragraphs (e)(2), (3), and (4), Sec. 1910.1003. (See Checklist). **(a)(1)** This section does not apply to solid or liquid mixtures containing less than 1.0 percent by weight or volume of beta-Propiolactone. **(a)(2)** NOTE: All of the requirements of Sec. 1910.1013(b) through 1910.1013(g)(2)(iii) are incorporated in a "Checklist" which follows Section 1910.1016. **(a)(3)**		
† **1910.1014 – 2-ACETYLAMINOFLUORENE** If you manufacture, process, repackage, release, handle, or store 2-Acetylaminofluorene, Chemical Abstracts Service Registry Number 53963, this entire section applies. This section does not apply to the transshipment in sealed containers, except for the labeling requirements under paragraphs (e)(2), (3), and (4), Sec. 1910.1003. (See Checklist). **(a)(1)** This section does not apply to solid or liquid mixtures containing less than 1.0 percent by weight or volume of 2-Acetylaminofluorene. **(a)(2)** NOTE: All of the requirements of Sec. 1910.1014(b) through 1910.1014(g)(2)(iii) are incorporated in a "Checklist" which follows Sec. 1910.1016. **(a)(3)**		

† These standards DO NOT apply to laboratory use of this chemical.

† 1910.1015 – 4-DIMETHYLAMINOAZOBENZENE

	YES	NO
If you manufacture, process, repackage, release, handle, or store 4-Dimethylaminoazobenzene, Chemical Abstracts Service Registry Number 60117, this entire section applies. This section does not apply to the transshipment in sealed containers, except for the labeling requirements under paragraphs (e)(2), (3), and (4), Sec. 1910.1003. (See Checklist). (a)(1)		
This section does not apply to solid or liquid mixtures containing less than 1.0 percent by weight or volume of 4-Dimethylaminoazobenzene. (a)(2)		
NOTE: All of the requirements of Sec. 1910.1015(b) through 1910.1015(g)(2)(iii) are incorporated in a "Checklist" which follows Sec. 1910.1016. (a)(2)		

† 1910.1016 – N-NITROSODIMETHYLAMINE

	YES	NO
If you manufacture, process, repackage, release, handle, or store N-Nitrosodimethylamine, Chemical Abstracts Service Registry Number 62759, this entire section applies. This section does not apply to the transshipment in sealed containers, except for the labeling requirements under paragraphs (e)(2), (3), and (4), Sec. 1910.1003. (See Checklist). (a)(1)		
This section does not apply to solid or liquid mixtures containing less than 1.0 percent by weight or volume of N-Nitrosodimethylamine. (a)(2)		
NOTE: All of the requirements of Sec. 1910.1016(b) through 1910.1016(g)(2)(iii) are incorporated in a "Checklist" which follows this section. (a)(2)		

† These standards DO NOT apply to laboratory use of this chemical.

CHECKLIST

Applicable to all items .1003 through .1016

	YES	NO
For definitions as used in this checklist, please see the Self-Inspection Appendix. (b)		
General Requirements		
Has a regulated area been established where carcinogen agents are manufactured, processed, released, handled, or stored? (c)		
Are all such areas controlled in accordance with the following requirements? (c)		
Are all employees working with carcinogen agents within an isolated system, such as a "glove box," required to wash their hands and arms upon completion of the assigned task, and before engaging in other activities not associated with the isolated system? (c)(1)		
Within regulated areas where carcinogen agents are stored in sealed containers, or contained in a closed system, including piping systems, with any sample ports or openings closed while carcinogen agents are contained within, is access restricted to authorized employees only? (c)(2)(i)		
Are employees required to wash hands, forearms, face and neck upon each exit from the regulated areas, close to the point of exit and before engaging in other activities? (c)(2)(ii)		
Are open vessel system operations prohibited? (c)(3)		
In operations involving "laboratory type hoods" or in locations where carcinogen agents are contained in an otherwise "closed system," but are transferred, charged or discharged into other normally closed containers, is access restricted to authorized employees only? (c)(4)(i)		
In operations listed directly above, is the operation provided with continuous local exhaust ventilation so that the air movement is always from ordinary work areas to the operation? (c)(4)(ii)		
Is the exhaust air from such local exhaust ventilation decontaminated prior to discharging into regulated areas, nonregulated areas, or the external environment? (c)(4)(ii)		
Is clean makeup air introduced in sufficient volume to maintain the correct operation of the local exhaust system? (c)(4)(ii)		
Are employees provided with, and required to wear, clean, full body protective clothing, shoe covers and gloves prior to entering the regulated area? (c)(4)(iii)		
Are employees engaged in carcinogen agent handling operations provided with and required to wear and use a half-face, filter-type respirator for dusts, mists, and fumes, in accordance with Sec. 1910.134? (c)(4)(iv)		
NOTE: A respirator affording higher levels of protection may be substituted. (c)(4)(iv)		
Prior to each exit from regulated areas, are employees required to remove and leave protective clothing and equipment at the point of exit? (c)(4)(v)		
At the last exit of the day from regulated areas, are employees required to place such clothing and equipment in impervious containers? (c)(4)(v)		

YES	NO

(Reserved for future use)

YES	NO

	YES	NO
Are the contents of such impervious containers identified as required under paragraphs (e)(2), (3), (4), of this section? (c)(4)(v)		
Are employees required to wash hands, forearms, face and neck on each exit from the regulated area, close to the point of exit, and before engaging in other activities? (c)(4)(vi)		
Are employees required to shower after the last exit of the day? (c)(4)(vii)		
Are drinking fountains prohibited in the regulated area? (c)(4)(viii)		
Is each authorized employee engaged in maintenance or decontamination activities, where contact with carcinogen agents could result, provided with and required to wear clean, impervious garments, including gloves, boots and continuous-air supplied hood? (c)(5)(i)		
Is each authorized employee involved in the above operation decontaminated before removing the protective garments and hood? (c)(5)(ii)		
Is each authorized employee required to shower upon removing the protective garments and hood? (c)(5)(iii)		
✱ In laboratory activities, where research and quality control activities involve the use of carcinogen agents, are you complying with the following:		
In all pipetting procedures, are mechanical pipetting aids used?		
Are all experiments, procedures and equipment which could produce aerosols confined to laboratory-type hoods or glove boxes?		
Are all surfaces on which carcinogen agents are handled protected from contamination?		
Are contaminated wastes and animal carcasses collected in impervious containers which are closed and decontaminated prior to removal from the work area?		
Are such wastes and carcasses incinerated in such a manner that no carcinogenic products are released?		
Are all other forms of carcinogen agents inactivated prior to disposal?		
Are all laboratory vacuum systems protected with high-efficiency scrubbers or with disposable absolute filters?		
✱ Are all employees engaged in animal support activities provided with, and required to wear:		
(a) A complete protective clothing change?		
Is the clothing clean each day?		
Does the clothing include coveralls or pants and shirt, foot covers, head covers, gloves, and appropriate respiratory protective equipment or devices?		
(b) Prior to each exit from regulated areas, are employees required to remove and leave protective clothing and equipment at the point of exit?		
At the last exit of the day from regulated areas, are employees required to place such clothing and equipment in impervious containers?		
Are the contents of such impervious containers identified as required under paragraphs (e)(2), (3), and (4) of this section?		
(c) Are employees required to wash hands, forearms, face and neck upon each exit from the regulated area close to the point of exit, and before engaging in other activities?		
(d) Are employees required to shower after the last exit of the day?		
✱ The following applies to employees, other than those engaged only in animal support activities each day:		
(a) Are employees provided with and required to wear a clean change of appropriate laboratory clothing, such as a solid front gown, surgical scrub suit, or fully buttoned laboratory coat?		
(b) Prior to each exit from regulated areas, are employees required to remove and leave protective clothing and equipment at the point of exit?		
At the last exit of the day from regulated areas, are employees required to place such clothing and equipment in impervious containers?		
Are the contents of such impervious containers identified as required under paragraphs (e)(2), (3), and (4) of this section?		
(c) Are employees required to wash hands, forearms, face and neck upon each exit from the regulated area close to the point of exit, and before engaging in other activities?		
✱ Is the air pressure in laboratory areas and animal rooms where carcinogen agents are handled and bioassay studies are performed negative in relation to the pressure in surrounding areas?		
✱ Is all exhaust air decontaminated prior to being discharged to regulated areas, non-regulated areas or the external environment?		
✱ Are steps taken to prevent connection between regulated areas and any other areas through the ventilation system?		
✱ Is a current inventory of carcinogen agents maintained?		
✱ Is ventilated apparatus, such as laboratory type hoods, tested at least semi-annually or immediately after ventilation modification or maintenance operations?		
✱ Is such test performed by personnel fully qualified to certify correct containment and operation?		

✱ Deleted from OSHA Standards 9/10/76. Retained here as a guide for laboratory procedures involving these substances.

	YES	NO
Regulated Area Requirements		
In an emergency, are immediate measures, including the following, implemented? (d)(2)		
Is the potentially affected area evacuated as soon as the emergency has been determined? (d)(2)(i)		
Are hazardous conditions created by the emergency eliminated? (d)(2)(ii)		
Is the potentially affected area decontaminated prior to the resumption of normal operations? (d)(2)(ii)		
Are arrangements made for special medical surveillance by a physician to be instituted within 24 hours for employees present in the potentially affected area at the time of the emergency? (d)(2)(iii)		
Has a report of the medical surveillance and any treatment provided been reported to the nearest OSHA area director as required by 1910.1003(f)(2)? (d)(2)(iii)		
If an employee has a known contact with carcinogen agents, is such an employee required to shower as soon as possible, unless contraindicated by physical injuries? (d)(2)(iv)		
Was an incident report on the emergency reported immediately or within 24 hours to the OSHA area director as required by 1910.1003(f)(2)? (d)(2)(v)		
Is the storage or consumption of food, storage or use of containers of beverages, storage or application of cosmetics, smoking, storage of smoking materials, tobacco products or other products for chewing, or the chewing of such products prohibited in regulated areas? (d)(3)(i)		
Are washing facilities, where employees are required by this section to wash, provided in accordance with 1910.141(d)(1) and (2)(ii) through (vii)? (d)(3)(ii)		
Where employees are required by this section to shower, are shower facilities provided in accordance with 1910.141(d)(3)? (d)(3)(iii)		
Where employees wear protective clothing and equipment, are clean change rooms provided, and are they in accordance with 1910.141(e), for the number of such employees required to change clothes? (d)(3)(iv)		
If toilets are in regulated areas, are such toilets in a separate room? (d)(3)(v)		
Contamination control (d)(4)		
Are inside regulated areas maintained under pressure negative with respect to non-regulated areas? (d)(4)(i)		
If local exhaust ventilation is used to satisfy this requirement, is clean makeup air in equal volume provided to replace the air removed? (d)(4)(i)		
Is the movement of any equipment, material or other item into or out of a regulated area done so in a manner that does not cause contamination in non-regulated areas or the external environment? (d)(4)(ii)		
Are decontamination procedures established and implemented to remove carcinogen agents from the surfaces of materials, equipment and the decontamination facility? (d)(4)(iii)		
Is dry sweeping and dry mopping prohibited? (d)(4)(iv)		
Signs - Information and Training		
Are entrances to regulated areas posted with a sign bearing the legend: CANCER-SUSPECT AGENT AUTHORIZED PERSONNEL ONLY (e)(1)(i)		
Is there a sign posted bearing the following legend at each entrance to regulated areas, where cleanup of leaks or spills, maintenance or repair operations on contaminated systems or equipment, or any operations involving work in an area where contact with carcinogen agents result: CANCER-SUSPECT AGENT EXPOSED IN THIS AREA IMPERVIOUS SUIT INCLUDING GLOVES, BOOTS, AND AIR-SUPPLIED HOOD REQUIRED AT ALL TIMES AUTHORIZED PERSONNEL ONLY (e)(1)(ii)		
Are appropriate signs and instructions posted at the entrance to, and exit from, regulated areas, informing employees of the procedures that must be followed in entering and leaving a regulated area? (e)(1)(iii)		
Are containers of carcinogen agents, and containers containing contaminated clothing and equipment in impervious containers, which are accessible to or handled by employees other than authorized employees, or employees that are trained in accordance with subparagraph (5) of this paragraph, have the contents identified, which includes the full chemical name and Chemical Abstracts Service Registry number? (e)(2)(ii)		
Do the containers have the warning words "CANCER-SUSPECT AGENT" displayed immediately under or adjacent to the contents identification? (e)(2)(iii)		
Do the containers which have carcinogen agents contents with corrosive or irritating properties have a label stating a warning of such hazards, noting, if appropriate, particularly sensitive or affected portions of the body? (e)(2)(iv)		
Do the letterings on signs and instructions have a minimum letter height of 2 inches? (e)(3)		
Do the labels on containers required under this section have lettering at least one-half the size of the largest lettering on the package, and not less than 8 point type in any instance? (e)(3)		
NOTE: The lettering on labels need not be more than 1 inch in height. (e)(3)		
Are precautions taken to provide that no statement appears on or near any required sign, label, or instruction which would contradict or detract from the effect of any required warning, information or instruction? (e)(4)		

	YES	NO
Does each employee prior to being authorized to enter a regulated area, receive a training and indoctrination program that includes at least the following items? (e)(5)(i)		
(a) The nature of the carcinogenic hazards of carcinogen agents, including local and systemic toxicity;		
(b) The specific nature of the operation involving carcinogen agents which could result in exposure;		
(c) The purpose for and application of the medical surveillance program, including, as appropriate, methods of self-examination;		
(d) The purpose for and application of decontamination practices and purposes;		
(e) The purpose for and significance of emergency practices and procedures;		
(f) The employee's specific role in emergency procedures;		
(g) Specific information to aid the employee in recognition and evaluation of conditions and situations which may result in the release of carcinogen agents?		
(h) The purpose for and application of specific first aid procedures and practices;		
(i) A review of this section at the employee's first training and indoctrination program and annually thereafter. (e)(5)(i)		
Are specific emergency procedures prescribed, and posted? (e)(5)(ii)		
Are employees familiarized with their terms, and rehearsed in their application? (e)(5)(ii)		
Are all training and indoctrination materials relating to this program available upon request to authorized representatives of the Assistant Secretary and the Director of NIOSH? (e)(5)(iii)		
Reports		
Have the required reports been forwarded to the nearest OSHA area director prior to March 1, 1974? (f)(1)		
If any changes have been made in such information, has this similarly been reported in writing to the OSHA area director within 15 calendar days of such changes? (f)(1)		
Did the reports, and will the reports, have the following items contained therein? (f)(1)		
(i) A brief description and in-plant location of the area(s) regulated and the address of each regulated area;		
(ii) The name(s) and other identifying information as to the presence of carcinogen agents in each regulated area;		
(iii) The number of employees in each regulated area, during normal operations including maintenance activities;		
(iv) The manner in which carcinogen agents are present in each regulated area — whether it is manufactured, processed, used, packaged, released, stored, or otherwise handled. (f)(1)		
Are procedures established whereby the nearest OSHA Area Director will be notified within 24 hours of incidents which result in the release of carcinogen agents into any area where employees may be potentially exposed? (f)(2)		

	YES	NO
Does this incident report have all the facts obtainable at that time, including a report of any medical treatment of affected employees? (f)(2)(i)		
Is a written report filed with the nearest OSHA Area Director within 15 calendar days, and does this report include:		
(a) A specification of the amount of material released?		
(a) The amount of time involved?		
(a) An explanation of the procedure used in determining this figure?		
(b) A description of the area involved, and the extent of known and possible exposure and area contamination?		
(c) A report of any medical treatment of affected employees, and any medical surveillance program implemented?		
(d) An analysis of the circumstances of the incident, and measures taken or to be taken with specific completion dates, to avoid further similar releases? (f)(2)(ii)		
Medical Surveillance		
Has a program of medical surveillance been established and implemented for employees considered for assignment to enter regulated areas, and for other authorized employees? (g)		
Before an employee is assigned to enter a regulated area, is there a pre-assignment physical examination by a physician provided? (g)(1)(i)		
Does the examination include the personal history of the employee, family and occupational background, including genetic and environmental factors? (g)(1)(i)		
Are authorized employees provided with a periodic physical examination at least annually, following the preassignment examination? (g)(1)(ii)		
In conducting the physical examination, is the examining physician required to consider whether there exist conditions of increased risk, including reduced immunological competence, those undergoing treatment with steroids or cytotoxic agents, pregnancy and cigarette smoking? (g)(1)(iii)		
Are records of all employees' physical examinations maintained completely and accurately? (g)(2)(i)		
Are arrangements made upon termination of the employee's employment, including retirement or in the event that the employer ceases business without a successor, to forward such records by registered mail to the director of NIOSH? (g)(2)(i)		
Are these records available upon request to the authorized representatives of the Assistant Secretary or the Director, upon request of an employee or former employee, to a physician designated by the employee, or to a new employer? (g)(2)(ii)		
Is the physician who conducts a medical examination required to furnish to the employer a statement of the employee's suitability for employment in the specific exposure? (g)(2)(iii)		

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	YES	NO
The following permanent standards became effective April 1, 1975.		
Scope and application. (a)		
This section applies to any area or operation in which vinyl chloride (chlorocthene), Chemical Abstracts Service Registry Number 75015, is manufactured, reacted, handled, processed, released, packaged, repacked, or stored. (a)(1)		
This section does not apply to the handling, storage, or other use of vinyl chloride polymers and copolymers in the form of fabricated products. (a)(2)		
This section applies to the transportation of vinyl chloride or polyvinyl chloride except to the extent that the Department of Transportation may regulate the hazards covered by this section. (a)(3)		
Is the occupational environment controlled so that no employee is exposed to vinyl chloride at a concentration in excess of 5 parts per million (ppm) (12.70 mg/cum)? (b)		
Are precautions taken to ensure that no employee is exposed to vinyl chloride (VC) at concentrations greater than 1ppm time weighted average (TWA) over an 8 hour period? (c)(1)		
Are precautions taken to ensure that no employee is exposed to VC at concentrations greater than 5ppm average over any period not exceeding 15 minutes? (c)(2)		
Are precautions taken to ensure that no employee is exposed to VC by direct contact with liquid VC? (c)(3)		
Monitoring. (d)		
Has a program of initial monitoring and measurement been undertaken to determine if there is any employee exposed, without regard to the use of respirators in excess of the action level? (d)(1)		
NOTE: Action level means a concentration of vinyl chloride of 0.5ppm averaged over an 8 hour work day.		
When employee exposure levels are determined to be in excess of the action level, has a program for determining exposures for each employee been established? (d)(2)		
Is such a program repeated at least monthly where any employee is exposed, without regard to the use of respirators, in excess of the permissible exposure limit? (d)(2)(i)		
Is such a program repeated at least quarterly where any employee is exposed, without regard to the use of respirators, in excess of the action level? (d)(2)(ii)		
Are such programs discontinued for an employee only when at least two consecutive monitoring determinations made not less than 5 working days apart show exposures for that employee at or below the action level? (d)(2)(iii)		
Is a determination made of employee exposure as required by (d)(1) above whenever there has been a production process or control change which may release VC, or when the employer has any other reason to suspect that any employee may have been exposed to VC in excess of the action level? (d)(3)		

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	YES	NO
Does the method of monitoring and measuring have an accuracy of not less than plus or minus 50% from 0.25 through 0.5ppm plus or minus 35% from 0.5ppm through 1.0ppm (with a confidence level of 95%)? (d)(4)		
Are employees or their designated representatives afforded a reasonable opportunity to observe the monitoring and measuring required? (d)(5)		
Regulated Areas. (e)		
Are regulated areas established where:		
Vinyl chloride or polyvinyl chloride is manufactured, reacted, repackaged, stored, handled or used? (e)(1)(i)		
Where vinyl chloride concentrations are in excess of the permissible exposure limit? (e)(1)(ii)		
Is access to regulated areas limited to authorized persons? (e)(2)		
® Is a daily roster made of authorized persons who enter regulated areas? (e)(2)		
Methods of Compliance. (f)		
Are employee exposures to vinyl chloride controlled to or below the permissible exposure limits by engineering, work practices, and personal protective controls as follows: (f)		
By feasible engineering and work practice controls that will immediately be utilized to reduce exposures to at or below the permissible exposure limit? (f)(1)		
Where such engineering and work practice controls are not sufficient to reduce exposures to at or below the permissible exposure limit, are they nonetheless used to reduce exposures to the lowest practicable level? (f)(2)		
Is respiratory protection in accordance with item (g) used to supplement such controls? (f)(2)		
Is a program established and implemented to reduce exposures to at or below the permissible exposure limit, or to the greatest extent feasible, solely by means of engineering and work practice controls as soon as feasible? (f)(2)		
Are written plans for such a program developed and capable of being furnished, upon request, for examination and copying to the authorized representatives of the Assistant Secretary of Labor for OSHA and the Director of NIOSH? (f)(3)		
Are such plans updated at least each six months? (f)(3)		
Respiratory protection. (g)		
Are employees provided with and required to wear respirators when they are required? (g)(1)		
EXCEPTION: Until April 1, 1976 the wearing of respirators is at the discretion of employees when the exposure to VC is not in excess of 25ppm measured over any 15 minute period.		
Are those employees who assert the above discretion informed at least quarterly of the hazards of vinyl chloride and the purpose, proper use, and limitations of respiratory devices? (g)(1)		

® Revoked

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	YES	NO
Are respirators selected from those jointly approved by the Mining Enforcement and Safety Administration, U.S. Dept. of the Interior and the National Institute for Occupational Safety and Health? (g)(1)		
Does the respiratory protection program meet the requirements of 1910.134? (g)(3)		
Is the selection of respirators for vinyl chloride based on the following: (g)(4)		
Unknown, or above 3,600 ppm:		
Open-circuit, self-contained breathing apparatus, pressure demand type, with a full facepiece. (i)		
Not over 3,600 ppm:		
(A) Combination type C supplied air respirator, pressure demand type, with full or half facepiece, and auxiliary self-contained air supply; or		
(B) Type C, supplied air respirator continuous flow type, with full or half facepiece, and auxiliary self-contained air supply. (ii)		
Not over 100 ppm:		
(A) Combination type C supplied air respirator demand type, with full facepiece, and auxiliary self-contained air supply; or		
(B) Open-circuit self-contained breathing apparatus with full facepiece, in demand mode; or		
(C) Type C supplied air respirator, demand type, with full facepiece. (iii)		
Not over 25 ppm:		
(A) A powered air-purifying respirator with hood, helmet, full or half facepiece, and a canister which provides a service life of at least 4 hours for concentrations of vinyl chloride up to 25 ppm; or		
(B) Gas mask, front- or back-mounted canister which provides a service life of at least 4 hours for concentrations of vinyl chloride up to 25 ppm. (iv)		
Not over 10 ppm:		
(A) Combination type C supplied-air respirator, demand type, with half facepiece, and auxiliary self-contained air supply; or		
(B) Type C supplied-air respirator, demand type, with half facepiece; or		
(C) Any chemical cartridge respirator with an organic vapor cartridge which provides a service life of at least 1 hour for concentrations of vinyl chloride up to 10 ppm. (v)		
Is entry into unknown concentrations or concentrations greater than 36,000ppm (LEL) limited to life rescue purposes only? (g)(5)(i)		
Is entry into concentrations of less than 36,000ppm, but greater than 3,600ppm made only for purposes of life rescue, firefighting, or securing equipment so as to prevent a greater hazard from release of vinyl chloride? (g)(5)(ii)		

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	YES	NO
Are air-purifying canisters or cartridges replaced prior to the expiration of their service life or the end of the shift in which they are first used, whichever occurs first? (g)(6)(i)		
Is a continuous monitoring and alarm system provided where concentrations of vinyl chloride could reasonably exceed the allowable concentrations for the devices used? (g)(6)(ii)		
Are such systems used to alert employees when vinyl chloride concentrations exceed the allowable concentrations for the devices in use? (g)(6)(ii)		
NOTE: Apparatus prescribed for higher concentrations may be used for any lower concentration. (g)(7)		
Hazardous Operations. (h)		
Definition:		
"Hazardous operation means any operation, procedure, or activity where a release of either vinyl chloride liquid or gas might be expected as a consequence of the operation or because of an accident in the operation, which would result in an employee exposure in excess of the permissible exposure limit."		
Are employees engaged in hazardous operations, including entry of vessels to clean polyvinyl chloride residue from vessel walls provided with and required to wear and use:		
Respiratory protection in accordance with (c) and (g) above; and (h)(1)(i)		
Protective garments to prevent skin contact with liquid vinyl chloride or polyvinyl chloride residue from vessel walls? (h)(1)(ii)		
Are such garments selected for the operation and its possible exposure conditions? (h)(1)(ii)		
Are such garments provided clean and dry for each use? (h)(2)		
Emergency situations. (i)		
Has there been developed a written operational plan for emergency situations for each facility storing, handling, or otherwise using vinyl chloride as a liquid or compressed gas? (i)		
Are precautions taken to ensure that appropriate portions of the plan will be implemented in the event of an emergency? (i)		
Does each plan specifically provide that:		
Employees engaged in hazardous operations or correcting situations of existing hazardous releases will be equipped as required in (h) above; and (i)(1)		
Other employees not so equipped will be required to evacuate the area and not return until conditions are controlled by the methods required in (f) above and the emergency is abated. (i)(2)		
Training. (j)		
Has each employee engaged in vinyl chloride or polyvinyl chloride operations been provided training in a program relating to the hazards of vinyl chloride and the precautions for its safe use? (j)		

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	YES	NO
Does the program include:		
The nature of the health hazard from chronic exposure to vinyl chloride including specifically the carcinogenic hazard? (j)(1)(i)		
The specific nature of operations which could result in exposure to vinyl chloride in excess of the permissible limit and necessary protective steps? (j)(1)(ii)		
The purpose for, proper use, and limitations of respiratory protective devices? (j)(1)(iii)		
The fire hazard and acute toxicity of vinyl chloride, and the necessary protective steps? (j)(1)(iv)		
The purpose for and a description of the monitoring program? (j)(1)(v)		
The purpose for and a description of the medical surveillance program? (j)(1)(vi)		
Emergency procedures? (j)(1)(vii)		
Specific information to aid the employee in recognition of conditions which may result in the release of vinyl chloride? (j)(1)(viii)		
A review of this standard at the employee's first training and indoctrination program and annually thereafter? (j)(1)(ix)		
Are all materials relating to the above program available upon request to the Assistant Secretary of Labor for OSHA and the Director of NIOSH? (j)(2)		
Medical surveillance. (k)		
Has a program of medical surveillance been instituted for each employee exposed to vinyl chloride, without regard to the use of respirators, in excess of the action level? (k)		
Does this program provide each such employee with an opportunity for examinations and tests in accordance with this paragraph? (k)		
Are all examinations and procedures performed by, or under the supervision of a licensed physician at no cost to the employee? (k)		
Are such examinations given to employees at the time of the initial assignment or upon institution of medical surveillance? (k)(1)		
Is a general physical examination performed with specific attention to detecting enlargement of liver, spleen or kidneys, or dysfunction in these organs and abnormalities in skin, connective tissue and the pulmonary system? (k)(1)(i)		
Is a medical history taken and does it include the following topics: (k)(1)(ii)		
Alcohol intake? (A)		
Past history of hepatitis? (B)		
Work history and past exposure to potential hepatoxic agents, including drugs and chemicals? (C)		
Past history of blood transfusions? (D)		
Past history of hospitalization? (E)		

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	YES	NO
Are serum specimens obtained and determinations made of: (k)(1)(iii)		
Total bilirubin? (A)		
Alkaline phosphatase? (B)		
Serum glutamic oxalacetic transaminase (SGOT)? (C)		
Serum glutamic pyruvic transaminase (SGPT)? (D)		
Gamma glustamyl transpeptidase? (E)		
Are such examinations performed at least:		
Every six months for employees who have been employed in vinyl chloride or polyvinyl chloride manufacture for 10 years or longer? (k)(2)(i)		
Are all other employees provided with such examinations at least annually? (k)(2)(ii)		
Is each employee exposed to an emergency afforded appropriate medical surveillance? (k)(3)		
Is a statement of each employee's suitability for continued exposure to vinyl chloride, including use of respirators and protective equipment, obtained from the examining physician promptly after the examination? (k)(4)		
Is a copy of such statement provided to the employee? (k)(4)		
Are employees withdrawn from possible contact with vinyl chloride if their health would be materially impaired by continued exposure? (k)(5)		
Are laboratory analyses performed in laboratories licensed under 42 CFR Part 74? (k)(6)		
Is any deviation from the examination required by (k)(1) above verified by a statement from the examining physician setting forth the alternative examination and the rationale for substitution? (k)(7)		
Is such statement available upon request for examination and copying to representatives of the Assistant Secretary or the Director of NIOSH? (k)(7)		
Signs and labels. (l)		
Are entrances to regulated areas posted with legibile signs bearing the legend: CANCER-SUSPECT AGENT AREA AUTHORIZED PERSONNEL ONLY (l)(1)		
Are areas containing hazardous operations or where an emergency currently exists posted with legible signs bearing the legend: CANCER-SUSPECT AGENT IN THIS AREA PROTECTIVE EQUIPMENT REQUIRED AUTHORIZED PERSONNEL ONLY (l)(2)		
Are containers of polyvinyl chloride resin waste from reactors or other waste contaminated with vinyl chloride legibly marked: CONTAMINATED WITH VINYL CHLORIDE CANCER-SUSPECT AGENT (l)(3)		

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	YES	NO
Are containers of polyvinyl chloride legibly labeled: POLYVINYL CHLORIDE (OR TRADE NAME) CONTAINS VINYL CHLORIDE VINYL CHLORIDE IS A CANCER-SUSPECT AGENT (l)(4)		
Are containers of vinyl chloride labeled either: VINYL CHLORIDE EXTREMELY FLAMMABLE GAS UNDER PRESSURE CANCER-SUSPECT AGENT (l)(5)(i)		
or in accordance with 49 CFR Part 173 Subpart H, Dept. of Tranportation (DOT) Regulation, with the additional legend: CANCER-SUSPECT AGENT applied near the label or placard. (l)(5)(ii)		
Are precautions taken to ensure that no statement appears on or near any required sign label or instruction which contradicts or detracts from the effect of any required warning or instruction? (l)(6)		
Records. (m)		
Do all records required by this section include the name and social security number of each employee where relevant? (m)(1)		
Are records of required monitoring and measuring, medical records, and authorized personnel rosters, made and are they available upon request for examination and copying by an authorized representative of the Assistant Secretary or the Director of NIOSH? (m)(2)		
Do monitoring and measuring records state the date of such monitoring and measuring and the concentrations determined and identify the instruments and methods used? (m)(2)(i)(A)		
Do such records contain any additional information necessary to determine individual employee exposures where such exposures are determined by means other than individual monitoring of employees? (m)(2)(i)(B)		

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	YES	NO
Are such records maintained for 30 years? (m)(2)(i)(C)		
Are medical records maintained for the duration of the employment of each employee plus 20 years or 30 years, whichever is longer? (m)(2)(iii)		
In the event an employer ceases to do business and there is no successor to receive the records, are arrangements made to forward the records to the Director of NIOSH? (m)(3)		
Are arrangements made to provide employees or their designated representatives access to examine and copy required monitoring and measurement records? (m)(4)		
Have arrangements been made to provide former employees access to examine and copy required monitoring and measuring records reflecting their own exposures? (m)(5)		
Are arrangements made to provide copies of medical records upon written request, to physician designated by the employee? (m)(6)		
Reports. (n)		
Within 1 month following the establishment of a regulated area has the following information been provided to the OSHA Area Director? (n)(1)		
The address and location of each establishment which has one or more regulated areas. (n)(1)(i)		
The number of employees in each regulated area during normal operation. (m)(1)(ii)		
Are arrangements made so that the OSHA Area Director will be notified within 24 hours of emergencies and the facts obtainable at that time? (n)(2)		
Are arrangements made so that when any monitoring and measurement is made that discloses that any employee has been exposed without regard to the use of a respirator, in excess of the permissible exposure limit, that each such employee will be notified in writing of the results of the exposure measurement and the steps being taken to reduce the exposure limit? (n)(3)		

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YES	NO

The following permanent standard became effective August 1, 1978; however, some provisions have different start-up dates, summarized as follows:

START-UP DATES – AS SOON AS POSSIBLE BUT NO LATER THAN:

September 15, 1978

Completion of initial monitoring. **(u)(2)**

October 1, 1978

Complete establishment of regulated areas. **(u)(3)**

Respirator use for employees exposed above 50 $\mu g/m^3$. **(u)(6)**

Completion of initial training. **(u)(6)**

Notification of use. **(u)(6)**

December 1, 1978

Respirator use over 10 $\mu g/m^3$. **(u)(6)**

Completion of initial medical. **(u)(6)**

Completion of compliance plan. **(u)(4)**

Optional use of powered air-purifying respirators. **(u)(6)**

July 1, 1979

Completion of lunchrooms and hygiene facilities. **(u)(5)**

December 31, 1979

Completion of engineering controls. **(u)(6)**

All other obligations of this standard commenced on August 1, 1978. **(u)(1)**

(a) **Scope and Application.** **(a)**

This section applies to all occupational exposures to inorganic arsenic except as follows:

Employee exposures in agriculture or resulting from pesticide application, the treatment of wood with preservatives or the utilization of arsenically preserved wood. **(a)**

NOTE: "Inorganic arsenic" means copper acetoarsenite and all inorganic compounds containing arsenic except arsine, measured as arsenic(As).

(c) **Permissible Exposure Limit (PEL)** **(c)**

Are the necessary steps taken to assure that no employee is exposed to inorganic arsenic at concentrations greater than 10 micrograms per cubic meter of air (10 $\mu g/m^3$), averaged over any 8-hour period? **(c)**

(d) **Notification of Use.** **(d)**

Is the following information reported in writing to the OSHA Area Office within 60 days following the establishment of a regulated area pursuant to (f) below: **(d)(1)**

The address of each such workplace? **(d)(1)(i)**

The approximate number of employees who will be working in regulated areas? **(d)(1)(ii)**

A brief summary of the operations creating the exposure and the actions which the employer intends to take to reduce exposures? **(d)(1)(iii)**

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YES	NO

NOTE: Whenever there has been a significant change in the information required to be reported, the employer shall report the changes in writing within 60 days to the OSHA Area Office. **(d)(2)**

(e) **Exposure Monitoring.** **(e)**

Have air samples been taken and measured to determine airborne exposure levels representative of each employee's exposure to inorganic arsenic over an 8-hour period? **(e)(1)(i)**

NOTE: For the purpose of this standard, employee exposure is that exposure which would occur if the employee were not using a respirator. **(e)(1)(ii)**

Are full shift (at least 7 consecutive hours) personal samples collected, including at least one sample for each shift for each job classification in each work area? **(e)(1)(iii)**

Has initial monitoring been conducted of each workplace and work operation to determine accurately the airborne concentration of inorganic arsenic to which employees may be exposed? **(e)(2)**

NOTE: If the initial monitoring reveals employee exposure to be below the "action level," the measurements need not be repeated unless a change is effected. **(e)(3)(i)**

NOTE: "Action level" means a concentration of inorganic arsenic of 5 micrograms per cubic meter of air (5 $\mu g/m^3$) averaged over any 8-hour period.

Is monitoring repeated at least quarterly when measurements reveal employee exposure to be above the permissible exposure limit (PEL) (10 $\mu g/m^3$)? **(e)(3)(ii)**

Is monitoring repeated at least every 6 months when measurements reveal employee exposure to be above the action level (5 $\mu g/m^3$) but below the PEL (10 $\mu g/m^3$)? **(e)(3)(iii)**

Is monitoring at the required frequency continued until at least two consecutive measurements, taken at least 7 days apart, are below the action level (may be discontinued thereafter)? **(e)(3)(iv)**

Is monitoring repeated whenever there has been a production, process, control or personnel change which may result in any new or additional exposure to inorganic arsenic, or whenever the employer has reason to suspect new or additional exposure? **(e)(4)**

Is each employee notified in writing, within 5 working days after receipt of the monitoring results, of the measurements which represent that employee's exposure? **(e)(5)(i)**

Whenever the PEL is exceeded, does the written notification include a statement that the permissible limit was exceeded and does it note the corrective actions being taken to reduce exposure to or below the PEL? **(e)(5)(ii)**

For concentrations of inorganic arsenic greater than or equal to 10 $\mu g/m^3$, does the method of monitoring and measurement have an accuracy (with a confidence level of 95%) of not less than plus or minus 25%? **(e)(6)(i)**

For concentrations of inorganic arsenic greater than 5 $\mu g/m^3$ but less than 10 $\mu g/m^3$, does the method of monitoring and measurement have an accuracy (with a confidence level of 95%) of not less than plus or minus 35%? **(e)(6)(ii)**

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	YES	NO
(f) Regulated Area. (f)		
Are regulated areas established where worker exposures to inorganic arsenic, without regard to the use of respirators, are in excess of PEL? (f)(1)		
Are regulated areas demarcated and segregated from the rest of the workplace in such a manner as to minimize the number of persons who will be exposed to inorganic arsenic? (f)(2)		
Is access to regulated areas limited to authorized persons? (f)(3)		
NOTE: "Authorized person" means any person specifically authorized by the employer whose duties require that person to enter a regulated area, or any person entering such an area as a designated representative of employees for the purpose of exercising the right to observe monitoring and measuring procedures.		
Is a respirator, selected in accordance with (h)(2) below, supplied to all persons entering a regulated area? (f)(4)		
Are steps taken to assure that, in regulated areas, food and beverages are not consumed, smoking products, chewing tobacco and gum are not used, and cosmetics are not applied? (f)(5)		
NOTE: These activities may be conducted in the lunchrooms, change rooms and showers required under (m) below. Drinking water may be consumed in the regulated area.		
(g) Methods of Compliance. (g)		
Are feasible engineering and work practice controls instituted to reduce exposures to or below the PEL (by December 31, 1979)? (g)(1)(i)		
Where such feasible engineering and work practice controls are not sufficient to reduce employee exposures to or below the PEL, are they nonetheless used to reduce exposures to the lowest levels achievable and then supplemented by use of respiratory protection and other necessary personal protective equipment? (g)(1)(ii)		
NOTE: Employee rotation is not required as a control strategy before respiratory protection is instituted.		
Is a written program established and implemented to reduce exposures to or below the PEL by means of engineering and work practice controls? (g)(2)(i)		
Does the written program include at least the following: (g)(2)(ii)		
A description of each operation in which inorganic arsenic is emitted; e.g., machinery used, material processed, controls in place, crew size, operating procedures and maintenance practices? (g)(2)(ii)(a)		
Engineering plans and studies used to determine methods selected for controlling exposure to inorganic arsenic? (g)(2)(ii)(b)		
A report of the technology considered in meeting the PEL? (g)(2)(ii)(c)		
Monitoring data? (g)(2)(ii)(d)		

	YES	NO
A detailed schedule for implementation of the engineering controls and work practices that cannot be implemented immediately, and for the adoption and implementation of any additional engineering and work practices necessary to meet the PEL? (g)(2)(ii)(e)		
Other relevant information? (g)(2)(ii)(g)		
NOTE: Whenever the PEL will not be achieved with engineering controls and work practices by December 31, 1979, the employer shall include in the compliance plan an analysis of the effectiveness of the various controls, shall install engineering controls and institute work practices on the quickest schedule feasible, and shall include in the compliance plan, and implement, a program to minimize the discomfort and maximize the effectiveness of respirator use. (g)(2)(ii)(f)		
Are written plans for these compliance programs available at the worksite for examination and copying by the Assistant Secretary of Labor, the Director of NIOSH, and any affected employee or authorized employee representatives? (g)(2)(iii)		
Are these plans revised at least every six months to reflect the current status of the program? (g)(2)(iv)		
(h) Respiratory Protection. (h)		
Are employees provided with and required to wear respirators in the following circumstances: (h)(1)		
During the time period necessary to install or implement feasible engineering or work practice controls? (h)(1)(i)		
In work operations such as maintenance and repair activities, in which the employer establishes that engineering and work practice controls are not feasible? (h)(1)(ii)		
In work situations in which engineering controls and supplemental work practice controls are not yet sufficient to reduce exposures to or below the PEL? (h)(1)(iii)		
In emergencies? (h)(1)(iv)		
Where respirators are required, is an appropriate respirator or combination of respirators selected from Table I below for inorganic arsenic compounds without significant vapor pressure, or Table II below for inorganic arsenic compounds which have significant vapor pressure? (h)(2)(i)		
Are respirators provided at no cost to the employee, and their use assured when conditions so warrant? (h)(2)(i)		
Where employee exposures exceed the PEL for inorganic arsenic (10 $\mu g/m^3$) and also exceed the relevant limit for particular gasses such as sulfur dioxide, is any air-purifying respirator supplied to the employee, equipped with a combination high-efficiency filter with an appropriate gas sorbent? (h)(2)(ii)		
Are respirators selected from among those approved by the National Institute for Occupational Safety and Health (NIOSH) under the program of 30 CFR Part 11? (h)(2)(iii)		

TABLE I. – Respiratory protection for inorganic arsenic particulate except for those with significant vapor pressure

Concentration of inorganic arsenic (as As) or condition of use	Required respirator
(i) Unknown or greater or lesser than 20,000 $\mu g/m^3$ (20 mg/m^3) or firefighting.	(A) Any full facepiece self-contained breathing apparatus operated in positive pressure mode.
(ii) Not greater than 20,000 $\mu g/m^3$ (20 mg/m^3)	(A) Supplied air respirator with full facepiece, hood, or helmet or suit and operated in positive pressure mode.
(iii) Not greater than 10,000 $\mu g/m^3$(10 mg/m^3)	(A) Powered air-purifying respirators in all inlet face coverings with high efficiency filters.[1] (B) Half-mask supplied air respirators operated in positive pressure mode.
(iv) Not greater than 500 $\mu g/m^3$	(A) Full facepiece air-purifying respirator equipped with high-efficiency filter.[1] (B) Any full facepiece supplied air respirator. (C) Any full facepiece self-contained breathing apparatus.
(v) Not greater than 100$\mu g/m^3$	(A) Half-mask air purifying respirator equipped with high-efficiency filter.[1] (B) Any half-mask supplied air respirator.

[1] High-efficiency filter—99.97 pct efficiency against 0.3 micrometer monodisperse diethyl-hexyl phthalate (DOP) particles.

TABLE II. – Respiratory protection for inorganic arsenicals (such as arsenic trichloride[2] and arsenic phosphide) with significant vapor pressure

Concentration of inorganic arsenic (as As) or condition of use	Required respirator
(i) Unknown or greater or lesser than 20,000 $\mu g/m^3$ (20 mg/m^3) or firefighting.	(A) Any full facepiece self-contained breathing apparatus operated in positive pressure mode.
(ii) Not greater than 20,000 $\mu g/m^3$(20 mg/m^3)	(A) Supplied air respirator with full facepiece hood, or helmet or suit and operated in positive pressure mode.
(iii) Not greater than 10,000 $\mu g/m^3$ (10 mg/m^3)	(A) Half mask [2] supplied air respirator operated in positive pressure mode.
(iv) Not greater than 500 $\mu g/m^3$	(A) Front or back mounted gas mask equipped with high-efficiency filter [1] and acid gas canister. (B) Any full facepiece supplied air respirator. (C) Any full facepiece self-contained breathing apparatus.
(v) Not greater than 100 $\mu g/m^3$	(A) Half mask [2] air-purifying respirator equipped with high- efficiency filter [1] and acid gas cartridge. (B) Any half-mask supplied air respirator.

[1] High efficiency filter—99.97 pct efficiency against 0.3 micrometer monodisperse diethyl-hexyl phthalate (DOP) particles.

[2] Half mask respirators shall not be used for protection against arsenic trichloride, as it is rapidly absorbed through the skin.

	YES	NO
Do the respirators issued to employees exhibit minimum facepiece leakage, and are they properly fitted? (h)(3)(i)		
Is fit testing of respirators performed in accordance with the following?		
Qualitative fit tests shall be performed at the time of initial fitting, and at least semi-annually thereafter for each employee wearing respirators, where quantitative fit tests are not required. (h)(3)(ii)		
For employers with more than 20 employees wearing respirators, quantitative face fit tests shall be performed at the time of initial fitting, and at least semi-annually thereafter for each employee wearing negative pressure respirators. (h)(3)(iii)		
Are employees who demonstrate difficulty in breathing, during the fitting test or during use, examined by a physician trained in pulmonary medicine to determine whether the employee can wear a respirator while performing the required duty? (h)(3)(iv)		
Does the respiratory protection program meet the requirements of 1910.134 (b), (d), (e) and (f)? (h)(4)(i)		
Are employees permitted to change the filter elements whenever an increase in breathing resistance is detected? (h)(4)(ii)		
Is an adequate supply of filter elements maintained? (h)(4)(ii)		
Are employees who wear respirators permitted to leave work areas to wash their face and respirator face-piece to prevent skin irritation associated with respirator use? (h)(4)(iii)		
NOTE: The employer's obligation to provide respirators commenced on August 1, 1978 for employees exposed over 500 μg/m³; not later than October 1, 1978 for employees exposed over 50 μg/m³; and not later than December 1, 1978 for employees exposed between 10 and 50 μg/m³; however, employees with exposures below 50 μg/m³ may choose not to wear respirators until December 31, 1979. After December 1, 1978 any employee required to wear air purifying respirators may choose, and if the employee so chooses the employer must provide, if it will give proper protection, a powered air-purifying respirator and in addition if necessary a combination dust and acid gas respirator for times where exposures to gases are over the relevant exposure limits. (h)(5)		
(j) **Protective Work Clothing and Equipment.** (j)		
Where the possibility of skin or eye irritation from inorganic arsenic exists and for all work in regulated areas, are employees provided with and required to use appropriate and clean protective work clothing and equipment such as, but not limited to: (j)(1)		
Coveralls or similar full-body work clothing? (j)(1)(i)		
Gloves, and shoes or coverlets? (j)(1)(ii)		
Face shields or vented goggles when necessary to prevent eye irritation, and which comply with the requirements of 1910.133 (a)(2) thru (a)(6)? (j)(1)(iii)		
Impervious clothing for employees subject to exposure to arsenic trichloride? (j)(1)(iv)		

	YES	NO
Is the required protective clothing provided in a freshly laundered and dry condition at least weekly, and daily if employee works in areas where exposures are over 100 μg/m³ of inorganic arsenic or in areas where more frequent washing is needed to prevent skin irritation? (j)(2)(i)		
Is the required protective clothing and equipment provided at no cost to the employee and is it cleaned, laundered, repaired, replaced or disposed of as needed to maintain its effectiveness? (j)(2)(ii)&(iii)		
Is all protective clothing removed only in change rooms? (j)(2)(iv)		
Is contaminated protective clothing which is to be cleaned, laundered, or disposed of, placed in a closed container in the change room which prevents dispersion of inorganic arsenic outside the container? (j)(2)(v)		
Has any person who cleans or launders the clothing required by this section been informed in writing of the potentially harmful effects, including the carcinogenic effects of exposure to inorganic arsenic? (j)(2)(vi)		
Are the containers of contaminated protective clothing and equipment in the workplace, or which are to be removed from the workplace, labelled as follows:		
CAUTION **CLOTHING CONTAMINATED WITH INORGANIC ARSENIC** **DO NOT REMOVE DUST BY BLOWING OR SHAKING** **DISPOSE OF INORGANIC ARSENIC CONTAMINATED WASH WATER IN ACCORDANCE WITH APPLICABLE LOCAL, STATE, OR FEDERAL REGULATIONS.** (j)(2)(vii)		
Is the removal of inorganic arsenic from protective clothing or equipment by blowing or shaking prohibited? (j)(2)(viii)		
(k) **Housekeeping.** (k)		
Are all surfaces maintained as free as practicable of accumulations of inorganic arsenic? (k)(1)		
Is cleaning, by use of compressed air, of floors and other accessible surfaces contaminated with inorganic arsenic prohibited? (k)(2)		
Is shoveling and brushing used only where vacuuming or other relevant methods have been tried and found not to be effective? (k)(2)		
Where vacuuming methods are selected, are the vacuums used and emptied in a manner to minimize the reentry of inorganic arsenic into the workplace? (k)(3)		
Is a written housekeeping and maintenance plan kept which lists appropriate frequencies for carrying out housekeeping operations, and for cleaning and maintaining dust collection equipment? (k)(4)		
Is periodic cleaning of dust collection and ventilation equipment and checks of their effectiveness carried out to maintain the effectiveness of the system, and is a notation kept of the last check of effectiveness and cleaning or maintenance? (k)(5)		

	YES	NO
(m) Hygiene Facilities and Practices. (m)		
Are clean change rooms equipped with storage facilities for street clothes and separate storage facilities for protective clothing and equipment provided, in accordance with 1910.141 (e), for employees working in regulated areas or subject to the possibility of skin or eye irritations from inorganic arsenic? (m)(1)		
Are employees who work in regulated areas or who are subject to the possibility of skin or eye irritation from inorganic arsenic required to shower at the end of the work shift? (m)(2)(i)		
Do shower facilities meet the requirements of 1910.141(d)(3)? (m)(2)(ii)		
Are lunchroom facilities which have a temperature controlled, positive pressure, filtered air supply, provided for and readily accessible to employees working in regulated areas? (m)(3)(i)		
Are employees who work in regulated areas or who are subject to the possibility of skin or eye irritation from exposure to inorganic arsenic required to wash their hands and face prior to eating? (m)(3)(ii)		
Do lavatory facilities meet the requirements of 1910.141(d)(1) and (2)? (m)(4)		
Are facilities provided and use assured for employees, working in areas where exposure without regard to the use of respirators exceeds 100 $\mu g/m^3$, to vacuum their protective clothing and clean or change shoes worn in such areas before entering change rooms, lunchrooms or shower rooms? (m)(5)		
Are precautions taken to assure that no employee is exposed to skin or eye contact with arsenic trichloride, or to skin or eye contact with liquid or particulate inorganic arsenic which is likely to cause skin or eye irritation? (m)(6)		
(n) Medical Surveillance. (n)		
Has a medical surveillance program been instituted for the following employees: (n)(1)		
All employees who are or will be exposed above the action level (5 $\mu g/m^3$), at least 30 days per year? (n)(1)(i)(a)		
All employees who have been exposed above the action level for 30 days or more per year for a total of 10 years or more of combined employment, with the current employer or predecessor employers, prior to or after the effective date of this standard (1 Aug 78)? (n)(1)(i)(b)		
NOTE: Exposure levels are without regard to the use of respirators. The determination of exposures prior to the effective date of this standard shall be based upon prior exposure records, comparison with the first measurements taken after the effective date of this standard, or comparison with records of exposures in areas with similar processes, extent of engineering controls utilized and materials used by that employer.		
Are all medical examinations and procedures performed by or under the supervision of a licensed physician and provided without cost to the employee, without loss of pay and at a reasonable time and place? (n)(1)(ii)		

	YES	NO
By December 1, 1978, or thereafter at time of initial assignment to an area where the employee is likely to be exposed over the action level at least 30 days per year, has each affected employee been provided an opportunity for a medical examination, including at least the following elements: (n)(2)		
A work history and a medical history which shall include a smoking history and the presence and degree of respiratory symptoms such as breathlessness, cough, sputum and production wheezing? (n)(2)(i)		
A 14" by 17" posterior-anterior chest X-ray and International Labor Office UICC/Cincinnati (ILO U/C) rating? (n)(2)(ii)(a)		
A nasal and skin examination? (n)(2)(ii)(b)		
A sputum cytology examination? (n)(2)(ii)(c)		
Other examinations which the physician believes appropriate because of the employee's exposure to inorganic arsenic or because of required respirator use? (n)(2)(ii)(d)		
Is the examination specified in (n)(2) above, with the exception of sputum cytology, provided at least annually for covered employees who are under 45 years of age with fewer than 10 years of exposure over the action level (5 $\mu g/m^3$)? (n)(3)(i)		
Is the total examination required by (n)(2) provided at least semi-annually for all other covered employees? (n)(3)(ii)		
Whenever a covered employee has not taken the required examination within 6 months preceding termination of employment, is such exam provided to the employee upon termination? (n)(3)(iii)		
If an employee for any reason develops signs or symptoms commonly associated with exposure to inorganic arsenic, is an appropriate examination and emergency medical treatment provided? (n)(4)		
Has the employer provided the following information to the examining physician: (n)(5)		
A copy of this standard and its appendices? (n)(5)(i)		
A description of the affected employee's duties as they relate to the employee's exposure? (n)(5)(ii)		
The employee's representative exposure level or anticipated exposure level? (n)(5)(iii)		
A description of any personal protective equipment used or to be used? (n)(5)(iv)		
Information from previous medical examinations of the affected employee which is not readily available to the examining physician? (n)(5)(v)		
Has a written opinion been obtained from the examining physician which includes: (n)(6)(i)		
The results of the medical examination and tests performed? (n)(6)(i)(a)		
The physician's opinion as to whether the employee has any detected medical conditions which would place the employee at increased risk of material impairment of the employee's health from exposure to inorganic arsenic? (n)(6)(i)(b)		

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	YES	NO
Any recommended limitations upon the employee's exposure to inorganic arsenic or upon the use of protective clothing or equipment such as respirators? (n)(6)(i)(c)		
A statement that the employee has been informed by the physician of the results of the medical examination and any medical conditions which require further explanation or treatment? (n)(6)(i)(d)		
Was the physician instructed not to reveal, in the written opinion, specific findings or diagnoses unrelated to occupational exposure? (n)(6)(ii)		
Has the affected employee been provided a copy of the written opinion? (n)(6)(iii)		
(o) **Employee Information and Training.** (o)		
Has a training program been instituted and participation assured for all employees who are subject to exposure to inorganic arsenic above the action level, or for whom there is the possibility of skin or eye irritation from inorganic arsenic? (o)(1)(i)		
Is training provided at the time of initial assignment, or upon institution of the training program, and repeated at least quarterly for employees who have optional use of respirators, and at least annually for other covered employees, and is each employee informed of the following: (o)(1)(ii)		
Information contained in Appendix A?* (o)(1)(ii)(a)		
Quantity, location, manner of use, storage, sources of exposure, and the specific nature of operations which could result in exposure to inorganic arsenic, as well as any necessary protective steps? (o)(1)(ii)(b)		
Purpose, proper use, and limitation of respirators? (o)(1)(ii)(c)		
The purpose and a description of the medical surveillance program as required by (n)? (o)(1)(ii)(d)		
Engineering controls and work practices associated with the employee's job assignment? (o)(1)(ii)(e)		
A review of this standard? (o)(1)(ii)(f)		
Is a copy of this standard and its appendices readily available to all affected employees? (o)(2)(i)		
Are all materials relating to the employee information and training program made available upon request to the Assistant Secretary of Labor and the Director of NIOSH? (o)(2)(ii)		
(p) **Signs and Labels.** (p)		
NOTE: The employer may use labels or signs required by other statutes, regulations, or ordinances in addition to, or in combination with, the signs and labels required below; however, no statement which contradicts or detracts shall appear on or near any required sign or label. (p)(1)		
Are signs bearing the following legend posted to demarcate the regulated area? (p)(2)(i)		

*See page Z-14g.

	YES	NO
DANGER **INORGANIC ARSENIC** **CANCER HAZARD** **AUTHORIZED PERSONNEL ONLY** **NO SMOKING OR EATING** **RESPIRATOR REQUIRED**		
Are the signs illuminated and cleaned as necessary so that the legend is readily visible? (p)(2)(ii)		
Are precautionary labels applied to all shipping and storage containers of inorganic arsenic, and to all products containing inorganic arsenic except when the inorganic arsenic in the product is bound in such a manner as to make unlikely the possibility of airborne exposure? (p)(3)		
NOTE: Possible examples of products not requiring labels are semi-conductors, light emitting diodes and glass.		
Do the required labels bear the following legend? (p)(3)		
DANGER **CONTAINS INORGANIC ARSENIC** **CANCER HAZARD** **HARMFUL IF INHALED OR SWALLOWED** **USE ONLY WITH ADEQUATE VENTILATION OR RESPIRATORY PROTECTION**		
(q) **Recordkeeping.** (q)		
Is an accurate record of all exposure monitoring required by (e) above, established and maintained? (q)(1)(i)		
Does the record include:		
The date(s), number, duration, location and results of each of the samples taken, including a description of the sampling procedure used to determine representative employee exposure? (q)(1)(ii)(a)		
A description of the sampling and analytical methods used and evidence of their accuracy? (q)(1)(ii)(b)		
Type of respiratory protection devices worn, if any? (q)(1)(ii)(c)		
Name, social security number, and job classification of the employees monitored, and of all other employees whose exposure the measurement is intended to represent? (q)(1)(ii)(d)		
The environmental variables that could affect the measurement of the employee's exposure? (q)(1)(ii)(e)		
Is this record maintained for at least 40 years, or the duration of employment plus 20 years, whichever is longer? (q)(1)(iii)		
Is an accurate record established and maintained for each employee subject to medical surveillance required by (n) above? (q)(2)(i)		

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Does the record include:		
Name, social security number, and description of duties of the employee? (q)(2)(ii)(a)		
A copy of the physician's written opinion? (q)(2)(ii)(b)		
Results of any exposure monitoring done for that employee and the representative exposure levels supplied to the physician? (q)(2)(ii)(c)		
Any employee medical complaints related to exposure to inorganic arsenic? (q)(2)(ii)(d)		
In addition to the above, does the employer keep or assure that the examining physician keeps the following medical records: (q)(2)(iii)		
A copy of the medical examination results, including medical and work history required by (n) above? (q)(2)(iii)(a)		
A description of the laboratory procedures and a copy of any standards or guidelines used to interpret the test results, or references to that information? (q)(2)(iii)(b)		
The initial X-ray? (q)(2)(iii)(c)		
The X-rays for the most recent 5 years? (q)(2)(iii)(d)		
Any X-rays with a demonstrated abnormality, and all subsequent X-rays? (q)(2)(iii)(e)		
The initial cytologic examination slide and written description? (q)(2)(iii)(f)		
The cytologic examination slide and written description for the most recent 5 years? (q)(2)(iii)(g)		
Any cytologic examination slides with demonstrated atypia, if such atypia persists for 3 years, and all subsequent slides and written descriptions? (q)(2)(iii)(h)		
Are these records maintained by the employer or the physician for at least 40 years, or the duration of employment plus 20 years, whichever is longer? (q)(2)(iv)		
Are all records required by this section made available upon request to the Assistant Secretary of Labor and the Director of NIOSH for examination and copying? (q)(3)(i)		
Are the records of employee exposure monitoring required by (q)(1) made available upon request, for inspection and copying, to affected employees, former employees and their designated representatives? (q)(3)(ii)		
Are an employee's medical records and exposure records, required by (q), made available upon request to the affected employee or former employee or to a physician designated by the affected employee or former employee? (q)(3)(iii)		
Has the following been accomplished when an employer ceases to do business:		
The successor employer shall receive and retain all records required to be maintained for the prescribed period? (q)(4)(i)		
When there is no successor employer to receive and retain the records, the employer shall transmit these records by mail to the Director of NIOSH? (q)(4)(ii)		

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	YES	NO
Is the Director of NIOSH notified 3 months prior to disposal of required records which have met the mandatory retention period, and are such records transmitted to the Director if he requests them within the 3-month period? (q)(4)(iii)		
(r) **Observation of Monitoring.** (r)		
Are affected employees, or their designated representatives, provided an opportunity to observe any required monitoring of employee exposure to inorganic arsenic? (r)(1)		
Are observers provided with necessary respirators and protective clothing or equipment, and are they required to comply with all applicable safety and health procedures when entering regulated areas? (r)(2)(i)		
Without interfering with the monitoring, are observers entitled to:		
Receive an explanation of the measurement procedures? (r)(2)(ii)(a)		
Observe all steps related to the monitoring of inorganic arsenic performed at the place of exposure? (r)(2)(ii)(b)		
Record the results obtained or receive copies of the results when returned by the laboratory? (r)(2)(ii)(c)		
(t) **Appendices.** (t)		
The information contained in the appendices (A, B, and C*) is not intended, by itself, to create any additional obligations not otherwise imposed by this standard, nor detract from any existing obligation. (t)		

(Next page is Z-17)

*See Self-Inspection Appendix

Q1

	YES	NO
(a) Scope and Application. (a)		
This standard applies to all occupational exposure to lead except as follows: (a)(1)		
Construction industry; (a)(2)		
Agricultural operations covered by Part 1928. (a)(2)		
(b) Definitions		
See page Z-iii.		
(c) Permissible Exposure Limit (PEL). (c)		
Are precautions taken to assure that no employee is exposed to lead at concentrations greater than 50 micrograms per cubic meter of air (50$\mu g/m^3$) averaged over an 8-hour period? (c)(1)		
NOTE: "Lead" means metallic lead, all inorganic lead compounds, and organic lead soaps. Excluded from this definition are all other organic lead compounds. (b)		
If an employee is exposed to lead for more than 8 hours in any work day, is the permissible exposure limit, as a time-weighted average (TWA) for that day, reduced according to the formula: "Maximum permissible limit (in $\mu g/m^3$) = 400 ÷ hours worked in the day"? (c)(2)		
NOTE: When respirators are used to supplement engineering and work practice controls to comply with the PEL, and all the requirements of (f) have been met, employee exposure for the purpose of determining whether the employer has complied with the PEL, may be considered to be at the level provided by the protection factor of the respirator for those periods the respirator is worn. Those periods may be averaged with exposure levels during periods when respirators are not worn to determine the employee's daily TWA exposure. (c)(3)		
(d) Exposure Monitoring. (d)		
NOTE: For the purpose of this section, employee exposure is that exposure which would occur if the employee were not using a respirator. (d)(1)(i)		
Are full shift (for at least seven continuous hours) personal samples collected, including at least one sample for each shift for each job classification in each work area? (d)(1)(ii)		
Are full shift personal samples representative of the monitored employee's regular, daily exposure to lead? (d)(1)(iii)		
Has an "initial determination" been made to determine if any employee may be exposed to lead at or above the "action level"? (d)(2)		
NOTE: "Action level" means employee exposure, without regard to the use of respirators, to an airborne concentration of lead of 30$\mu g/m^3$ averaged over an 8-hour period. (b)		
Are initial determinations based on the results of employee exposure monitoring and any of the following relevant considerations: (d)(3)(i)		
Any information, observations, or calculations which would indicate employee exposure to lead? (d)(3)(i)(A)		
Any previous measurements of airborne lead? (d)(3)(i)(B)		
Any employee complaints of symptoms which may be attributable to exposure to lead? (d)(3)(i)(C)		

	YES	NO
NOTE:		
(1) Monitoring for the initial determination may be limited to a representative sample of the exposed employees who the employer reasonably believes are exposed to the greatest airborne concentrations of lead in the workplace. (d)(3)(ii)		
(2) Measurements of airborne lead made in the preceding 12 months may be used to satisfy requirements to monitor if the sampling and analytical methods used meet the accuracy and confidence levels of (d)(9). (d)(3)(iii)		
When an initial determination shows possibility of exposures to other employees at or above the action level, is additional monitoring conducted to assure representative exposures for each employee in the workplace who is exposed to lead? (d)(4)		
When an initial determination shows that no employee is exposed at or above the action level, has a written record been made that includes the information in (d)(3), date of determination, location within the worksite, and the name and social security number of each employee monitored? (d)(5)		
NOTE: If the initial monitoring reveals employee exposure to be below the action level, the measurements need not be repeated except as required by (d)(7). (d)(6)(i)		
If the initial determination or subsequent monitoring reveals employee exposure to be at or above the action level but below the PEL, is monitoring repeated at least every six months? (d)(6)(ii)		
NOTE: Monitoring shall continue at the required frequency until at least two consecutive measurements, taken at least seven days apart, are below the action level, at which time the measurements need not be repeated except as required by (d)(7).		
If the initial determination reveals that employee exposure is above the PEL, is monitoring repeated quarterly? (d)(6)(iii)		
NOTE: Monitoring shall continue at the required frequency until at least two consecutive measurements, taken at least seven days apart, are below the PEL but at or above the action level, at which time the employer shall repeat monitoring for that employee at the frequency specified in (d)(6)(ii), except as otherwise provided in (d)(7).		
Is additional monitoring conducted whenever there has been a production, process, control or personnel change which may result in new or additional exposures to lead, or whenever the employer has any other reason to suspect a change which may result in new or additional exposures? (d)(7)		
Employee Notification. (d)(8)		
Is each employee notified in writing, within five working days after receipt of the monitoring results, of the measurements which represent that employee's exposure? (d)(8)(i)		
Whenever the results indicate that the representative employee exposure, without regard to respirators, exceeds the PEL, does the written notice include a statement that the PEL was exceeded, and a description of the corrective action taken or to be taken to reduce exposure to or below the PEL? (d)(8)(ii)		

YES	NO

Has a monitoring method been chosen which has an accuracy (95%) of not less than plus or minus 20% for airborne concentrations of lead equal to or greater than 30 $\mu g/m^3$? **(d)(9)**

(e) Methods of Compliance. **(e)**

Engineering and Work Practice Controls. **(e)(1)**

Are engineering and work practice controls (including administrative controls) implemented to reduce and maintain employee exposure to lead in accordance with the following implementation schedule? **(e)(1)**

NOTE: Failure to achieve exposure levels without regard to respirators is sufficient to establish a violation of this provision.

IMPLEMENTATION SCHEDULE

Industry[1]	Compliance Date 200 $\mu g/m^3$	100 $\mu g/m^3$	50 $\mu g/m^3$
Primary lead production	(3)	6/29/84[2]	6/29/91[2]
Secondary lead production	(3)	6/29/84[2]	6/29/86[2]
Lead acid battery manufacture	(3)	6/29/82[2]	6/29/86[2]
Automobile manufacture/ solder grinding	(3)	N/A	6/29/86[2]
Electronics, gray iron foundries, ink manufacture, paints and coating manufacture, wall paper manufacture, can manufacture and printing	(3)	N/A	6/29/82[2]
Brass and bronze ingot manufacture, lead chemical manufacture and secondary copper smelting	(3)	N/A	5 years[4]
Nonferrous foundries	(3)	N/A	5 years[4,5]
All other industries	(3)	N/A	2½ years[4]

[1] Includes ancillary activities located on the same work site.
[2] This date is calculated by counting from June 29, 1981 [the date the Supreme Court lifted the stay on the implementation of paragraph (e)(1)], the number of years specified for the particular industry in the original lead standard for compliance with the given airborne exposure level.
[3] On the effective date of this standard, March 1, 1979. This continues an obligation from Table Z-2 of 29 CFR 1910.1000, which has been in effect since 1971 but was deleted from the CFR upon the effectiveness of this standard.
[4] Expressed as the number of years from the date on which the court lifts the stay on the implementation of paragraph (e)(1) for the particular industry.
[5] Large nonferrous foundries (20 or more employees) are required to achieve 50 $\mu g/m^3$ by means of engineering and work practice controls. Small nonferrous foundries (fewer than 20 employees) are only required to achieve 75 $\mu g/m^3$ by such controls.

Are respirators used to supplement controls when engineering and work practice controls do not reduce employee exposure to or below the PEL? **(e)(2)**

YES	NO

Compliance Program. **(e)(3)**

Has a written compliance program been established and implemented to reduce exposures to or below the PEL, and interim levels if applicable, solely by means of engineering and work practice controls in accordance with (e)(1)? **(e)(3)(i)**

Does the written plan include at least the following: **(e)(3)(ii)**

A description of each operation in which lead is emitted; e. g. machinery used, material processed, controls in place, crew size, employee job responsibilities, operating procedures and maintenance practices? **(e)(3)(ii)(A)**

A description of the specific means that will be employed to achieve compliance, including engineering plans and studies used to determine methods selected for controlling exposure to lead? **(e)(3)(ii)(B)**

A report of the technology considered in meeting the permissible exposure limit? **(e)(3)(ii)(C)**

Air monitoring data which documents the source of lead emissions? **(e)(3)(ii)(D)**

A detailed schedule for implementation of the program, including documentation such as copies of purchase orders for equipment, construction contracts, etc.? **(e)(3)(ii)(E)**

A work practice program which includes items required under (g), (h) and (i) of this standard? **(e)(3)(ii)(F)**

An administrative control schedule required by (e)(6), if applicable? **(e)(3)(ii)(G)**

Other relevant information? **(e)(3)(ii)(H)**

Is the written program available at the worksite for examination and copying by the Assistant Secretary of Labor, the Director of NIOSH, and any affected employee or authorized employee representatives? **(e)(3)(iii)**

Is the written program revised and updated at least every six months to reflect the current status of the program? **(e)(3)(iv)**

Is the employer aware of the provisions to bypass the interim level as authorized in the following? **(e)(4)**

Where an employer's compliance plan provides for a reduction of employee exposures to or below the PEL solely by means of engineering and work practice controls in accordance with the implementation schedule in (e)(1), and the employer has determined that compliance with the 100$\mu g/m^3$ interim level would divert resources to the extent that it clearly precludes compliance, otherwise attainable, with the PEL by the required time, the employer may proceed with the plan to comply with the PEL in lieu of compliance with the interim level if:

The compliance plan clearly documents the basis of the determination. **(e)(4)(i)**

The employer takes all feasible steps to provide maximum protection for employees until the PEL is met. **(e)(4)(ii)**

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	YES	NO
The employer notifies the OSHA Area Director nearest the affected workplace, in writing, within 10 working days of the completion or revision of the compliance plan reflecting the determination. (e)(4)(iii)		
Mechanical Ventilation. (e)(5)		
When ventilation is used to control exposure, are measurements which demonstrate the effectiveness of the system, such as capture velocity, duct velocity, or static pressure, made at least every three months? (e)(5)(i)		
Are measurements of the ventilation system's effectiveness in controlling exposure made within five days of any change in production, process, or control which might result in a change in employee exposure to lead? (e)(5)(i)		
If air from exhaust ventilation is recirculated into the workplace, are the following precautions taken: (e)(5)(iii)		
The system has a high-efficiency filter with reliable back-up filter? (e)(5)(iii)(A)		
Controls to monitor the concentration of lead in the return air, and to bypass the recirculation system automatically if it fails, are installed, operating and maintained? (e)(5)(iii)(B)		
Administrative Controls. (e)(6)		
Has a job rotation schedule, which includes the following, been established and implemented when administrative controls are used as a means of reducing employee exposure: (e)(6)		
Name or identification number of each affected employee? (e)(6)(i)		
Duration and exposure levels at each job or work station where each affected employee is located? (e)(6)(ii)		
Any other information which may be useful in assessing the reliability of administrative controls to reduce exposure to lead? (e)(6)(iii)		
(f) **Respiratory Protection.** (f)		
Is an appropriate respirator provided at no cost to the employee and its use assured in the following circumstances: (f)(1)		
During the time period necessary to install or implement engineering or work practice controls, except that after the dates for compliance with the interim levels in (e)(1), no employer shall require an employee to wear a negative pressure respirator longer than 4.4 hours per day? (f)(1)(i)		
In work situations in which engineering and work practice controls are not sufficient to reduce exposures to or below the permissible exposure limit? (f)(1)(ii)		
Whenever an employee requests a respirator? (f)(1)(iii)		
Respirator Selection. (f)(2)		
Where respirators are required, is an appropriate respirator or combination of respirators selected based on the following? (f)(2)(i)		

RESPIRATORY PROTECTION FOR LEAD AEROSOLS

Airborne Concentration of Lead or Condition of Use	Required Respirator[1]
Not in excess of 0.5 $\mu g/m^3$ (10X PEL).	Half-mask, air-purifying respirator equipped with high efficiency filters.[2,3]
Not in excess of 2.5 $\mu g/m^3$ (50X PEL).	Full facepiece, air-purifying respirator with high efficiency filters.[3]
Not in excess of 50 $\mu g/m^3$ (1000X PEL).	(1) Any powered, air-purifying respirator with high efficiency filters[3]; or (2) Half-mask supplied-air respirator operated in positive-pressure mode.[2]
Not in excess of 100 $\mu g/m^3$ (2000X PEL).	Supplied-air respirators with full facepiece, hood, helmet, or suit, operated in positive pressure mode.
Greater that 100 $\mu g/m^3$, unknown concentration or fire fighting.	Full facepiece, self-contained breathing apparatus operated in positive-pressure mode.

[1] Respirators specified for high concentrations can be used at lower concentrations of lead.

[2] Full facepiece is required if the lead aerosols cause eye or skin irritation at the use concentrations.

[3] A high efficiency particulate filter means 99.97 percent efficient against 0.3 micron size particles.

	YES	NO
Is a powered air-purifying respirator with a high efficiency particulate filter provided, upon request of an employee, for use in concentrations not greater than 1000 times the PEL (required only when the physical characteristics of the employee are such that the respirators specified above are inadequate for the employee's protection)? (f)(2)(ii)		
Are respirators selected from among those approved for protection against lead dust, fume and mist by the Mine Safety and Health Administration and NIOSH under the provisions of 30 CFR Part 11? (f)(2)(iii)		
*Respirator Usage.** (f)(3)		
Are precautions taken to assure that the respirator issued to the employee exhibits minimum facepiece leakage, and that it is fitted properly? (f)(3)(i)		
Are quantitative or qualitative face fit tests performed at the time of initial fitting and at least semiannually thereafter for each employee wearning negative pressure respirators? (f)(3)(ii)		
Are qualitative fit tests used only for testing the fit of half-mask respirators in accordance with Appendix D? (f)(3)(ii)		

*See Volume 2, page 5-31 for a guide to a Respiratory Protection Program.

	YES	NO
Is the quantitative or qualitative test used to select facepieces that provide the required protection of (f)(2)(i)? (f)(3)(ii)		
If an employee exhibits difficulty in breathing during the fitting test or during use, is a medical examination made available to determine whether the employee can wear a respirator while performing the required duty? (f)(3)(iii)		
Respirator Program. (f)(4)		
Does the respirator program meet the requirements of 1910.134 (b), (d), (e) and (f)? (f)(4)(i)		
Is each employee who uses a filter respirator allowed to change the filter elements whenever an increase in breathing resistance is detected, and is an adequate supply of filter elements maintained for this purpose? (f)(4)(ii)		
Are employees who wear respirators permitted to leave work areas to wash their face and respirator facepiece whenever necessary to prevent skin irritation associated with respirator use? (f)(4)(iii)		
(g) **Protective Work Clothing and Equipment.** (g)		
Is the following protective clothing and equipment provided at no cost to the employee, and its use assured for exposures above the PEL (without regard to use of respirator) or where possibility of skin or eye irritation exists: (g)(1)		
Coveralls or similar full-body work clothing? (g)(1)(i)		
Gloves, hats, and shoes or disposable shoe coverlets? (g)(1)(ii)		
Face shields, vented goggles, or other appropriate protective equipment which complies with 1910.133? (g)(1)(iii)		
Is the required protective clothing furnished in a clean and dry condition at least weekly, and daily to employees whose exposure levels without regard to a respirator are over 200$\mu g/m^3$ of lead as an 8-hour TWA? (g)(2)(i)		
Are the following services or controls provided or accomplished by the employer in support of protective clothing and equipment:		
Cleaning, laundering, or disposal of protective clothing and equipment required by (g)(1)? (g)(2)(ii)		
Repair or replace as needed to maintain effectiveness? (g)(2)(iii)		
Assure that all protective clothing is removed at the completion of a work shift only in change rooms provided for that purpose, as prescribed in (i)(2)? (g)(2)(iv)		
Assure that contaminated protective clothing which is to be cleaned, laundered, or disposed of is placed in a closed container in the change-room, which prevents dispersion of lead outside the container? (g)(2)(v)		
Inform in writing any person who cleans or launders protective clothing or equipment of the potentially harmful effects of exposure to lead? (g)(2)(vi)		

	YES	NO
Assure that the containers of contaminated protective clothing and equipment are labeled as follows: **CAUTION** **CLOTHING CONTAMINATED WITH LEAD** **DO NOT REMOVE DUST BY BLOWING OR SHAKING** **DISPOSE OF LEAD-CONTAMINATED WASH WATER IN ACCORDANCE WITH APPLICABLE LOCAL, STATE, OR FEDERAL REGULATION** (g)(2)(vii)		
Prohibit the removal of lead from protective clothing or equipment by blowing, shaking, or any other means which disperses lead into the air? (g)(2)(viii)		
(h) **Housekeeping.** (h)		
Are all surfaces maintained as free as practicable of accumulations of lead? (h)(1)		
Is the use of compressed air prohibited for cleaning floors and other surfaces where lead accumulates? (h)(2)(i)		
Is shoveling, dry or wet sweeping and brushing used only where vacuuming or other equally effective methods have been tried and found not to be effective? (h)(2)(ii)		
Are vacuums used and emptied in a manner which minimizes the reentry of lead into the workplace? (h)(3)		
(i) **Hygiene Facilities and Practices.** (i)		
Are precautions taken to assure that in areas where employees are exposed to lead above the PEL, without regard to the use of respirators, food or beverage is not present or consumed, tobacco products are not present or used, and cosmetics are not applied, except in change rooms, lunchrooms, and showers required under (i)(2) through (i)(4)? (i)(1)		
Change Rooms. (i)(2)		
Are clean change rooms provided for employees who work in areas where their airborne exposure to lead is above the PEL? (i)(2)(i)		
Are the change rooms equipped with separate storage facilities for protective work clothing and equipment and for street clothes, so as to prevent cross-contamination? (i)(2)(ii)		
Showers. (i)(3)		
Are employees who work in areas where their airborne exposure to lead is above the PEL required to shower at the end of the work shift? (i)(3)(i)		
Are shower facilities provided in accordance with 1910.141(d)(3)? (i)(3)(ii)		
Are precautions taken to assure that employees who are required to shower do not leave the workplace wearing any clothing or equipment worn during the work shift? (i)(3)(iii)		

	YES	NO
Lunchrooms. (i)(4)		
Are lunchroom facilities provided for employees who work in areas where their airborne exposure to lead is above the PEL? (i)(4)(i)		
Does the lunchroom have a temperature-controlled, positive pressure, filtered air supply, and is it readily accessible to employees? (i)(4)(ii)		
Are precautions taken to assure that employees who work in areas where their airborne exposure to lead is above the PEL, wash their hands and face prior to eating, drinking, smoking or applying cosmetics? (i)(4)(iii)		
Are employees prohibited from entering lunchrooms with protective work clothing or equipment unless surface lead dust has been removed by vacuuming, downdraft booth or other cleaning method? (i)(4)(iv)		
Is an adequate number of lavatory facilities provided as required by 1910.141 (d)(1) and (2)? (i)(5)		
(j) **Medical Surveillance.** (j)		
Has a medical surveillance program been instituted for all employees who are or may be exposed above the action level for more than 30 days per year? (j)(1)(i)		
Are all medical examinations and procedures performed by or under the supervision of a licensed physician? (j)(1)(ii)		
Is the required medical surveillance, including multiple physician review as required by (j)(3)(ii), provided without cost to employees and at a reasonable time and place? (j)(1)(iii)		
Biological Monitoring. (j)(2)		
Is biological monitoring in the form of blood sampling and analysis for lead and zinc protoporphyrin levels made available to each employee covered under (j)(1)(i) on the following schedule: (j)(2)(i)		
At least every six months to each covered employee? (j)(2)(i)(A)		
At least every two months for each employee whose last blood sampling and analysis indicated a blood lead level at or above 40μg/100g of whole blood? This frequency shall continue until two consecutive blood samples and analyses indicate a blood lead level below 40μg/100g of whole blood. (j)(2)(i)(B)		
At least monthly during the removal period of each employee removed from exposure to lead due to an elevated blood lead level? (j)(2)(i)(C)		
Are follow-up blood sampling tests made within two weeks after the employer receives the results of the first test, whenever the results of a test indicate that an employee's blood lead level exceeds the numerical criterion for medical removal under (k)(1)(i)? (j)(2)(ii)		
Does the blood lead level sampling and analysis have an accuracy (to a confidence level of 95%) within plus or minus 15% or 6μg/100ml, whichever is greater, and is it conducted by a laboratory licensed by the Center for Disease Control (CDC), United States Department of Health, Education and Welfare, or which has received a satisfactory grade in blood lead proficiency testing from CDC in the prior 12 months? (j)(2)(iii)		

	YES	NO
Is each employee whose blood lead level exceeds 40μg/100g notified in writing of the following, within five working days after receipt of the biological monitoring results: (j)(2)(iv)		
That employee's blood lead level? (j)(2)(iv)(A)		
That the standard requires temporary medical removal with Medical Removal Protection benefits when an employee's blood lead level exceeds the numerical criterion for medical removal under (k)(1)(i)? (j)(2)(iv)(B)		
Medical Examinations and Consultations. (j)(3)		
Are medical examinations and consultations made available to each employee covered under (j)(1)(i) on the following schedule: (j)(3)(i)		
At least annually for each employee for whom a blood sampling test conducted at any time during the preceding 12 months indicated a blood lead level at or above 40μg/100g? (j)(3)(i)(A)		
Prior to assignment for each employee being assigned for the first time to an area in which airborne concentrations of lead are at or above the action level? (j)(3)(i)(B)		
As soon as possible, upon notification by an employee either that the employee has developed signs or symptoms commonly associated with lead intoxication, that the employee desires medical advice concerning the effects of current or past exposure to lead on the employee's ability to procreate a healthy child, or that the employee has demonstrated difficulty in breathing during a respirator fitting test or during use? (j)(3)(i)(C)		
As medically appropriate for each employee either removed from exposure to lead due to a risk of sustaining material impairment to health, or otherwise limited pursuant to a final medical determination? (j)(3)(i)(D)		
Do the medical examinations made available pursuant to (j)(3)(i)(A) through (B) include the following elements: (j)(3)(ii)		
A detailed work history and a medical history, with particular attention to past lead exposure (occupational and non-occupational), personal habits (smoking, hygiene), and past gastrointestinal, hematologic, renal, cardiovascular, reproductive and neurological problems? (j)(3)(ii)(A)		
A thorough physical examination with particular attention to teeth, gums, hematologic, gastrointestinal, renal, cardiovascular, and neurological systems? Pulmonary status should be evaluated if respiratory protection will be used. (j)(3)(ii)(B)		
A blood pressure measurement? (j)(3)(ii)(C)		
A blood sample and analysis which determines: (j)(3)(ii)(D)		
Blood lead level?		
Hemoglobin and hematocrit determination, red cell indices, and examination of peripheral smear morphology?		
Zinc protoporphyrin?		

	YES	NO
Blood urea nitrogen?		
Serum creatinine?		
A routine urinalysis with microscopic examination? (j)(3)(ii)(E)		
Any laboratory or other test which the examining physician deems necessary by sound medical practice? (j)(3)(ii)(F)		
Is the content of medical examinations made available pursuant to (j)(3)(i)(C) and (D) determined by an examining physician and, if so requested, by an employee, to include pregnancy testing or laboratory evaluation of male fertility? (j)(3)(ii)		
Is the following multiple physician review mechanism complied with when the employer selects the initial physician to conduct any medical examination or consultation provided to an employee? (j)(3)(iii)		
The employee may designate a second physician to review any findings, determinations or recommendations of the initial physician; and to conduct such examinations, consultations and laboratory tests as the second physician deems necessary to facilitate this review. (j)(3)(iii)(A)		
The employer shall promptly notify an employee of the right to seek a second medical opinion after each occasion that an initial physician conducts a medical examination or consultation pursuant to this standard. The employer may condition its participation in, and payment for, the multiple physician review mechanism upon the employee's doing the following within 15 days after receipt of the foregoing notification, or receipt of the initial physician's written opinion, whichever is later: (j)(3)(iii)(B)		
The employee informing the employer that he or she intends to seek a second medical opinion, and the employee initiating steps to make an appointment with a second physician.		
If the findings, determinations or recommendations of the second physician differ from those of the initial physician, then the employer and the employee shall assure that efforts are made for the two physicians to resolve any disagreement. (j)(3)(iii)(C)		
If the two physicians have been unable to quickly resolve their disagreement, then the employer and the employee through their respective physicians shall designate a third physician to: (j)(3)(iii)(D)		
Review any findings, determinations or recommendations of the prior physicians; and conduct such examinations, consultations, laboratory tests and discussion with the prior physicians as the third physician deems necessary to resolve the disagreement.		
The employer shall act consistent with the findings, determinations and recommendations of the third physician, unless the employer and the employee reach an agreement which is otherwise consistent with the recommendations of at least one of the three physicians. (j)(3)(iii)(E)		

	YES	NO
Is the following information provided the initial physician conducting the medical examination or consultation: (j)(3)(iv)(A)		
A copy of this regulation for lead, including all appendices?		
A description of the affected employee's duties as they relate to the employee's exposure?		
The employee's exposure level or anticipated exposure level to lead and to any other toxic substance, if applicable?		
A description of any personal protective equipment used or to be used?		
Prior blood lead determinations?		
All prior written medical opinions concerning the employee in the employer's possession or control?		
Is the foregoing information provided to a second or third physician conducting a medical examination or consultation upon request of the physician or the employee? (j)(3)(iv)(B)		
Has the employee been provided a copy of the written medical opinion from each examining or consulting physician, that contains the following: (j)(3)(v)(A)		
The physician's opinion as to whether the employee has any detected medical condition which would place the employee at increased risk of material impairment of the employee's health from exposure to lead?		
Any recommended special protective measures to be provided to the employee, or limitations to be placed upon the employee's exposure to lead?		
Any recommended limitation upon the employee's use of respirators, including a determination of whether the employee can wear a powered air-purifying respirator if a physician determines that the employee cannot wear a negative pressure respirator?		
The results of the blood lead determinations?		
Has each examining and consulting physician been instructed as follows: (j)(3)(v)(B)		
Not to reveal, either in the written opinion or in any other means of communication with the employer, findings, including laboratory results, or diagnoses unrelated to an employee's occupational exposure to lead?		
To advise the employee of any medical condition, occupational or non-occupational, which dictates further medical examination or treatment?		
NOTE: The employer and an employee or authorized employee representative may agree upon the use of any expeditious alternate physician determination mechanism in lieu of the multiple physician review mechanism provided by this paragraph, so long as the alternate mechanism otherwise satisfies the requirements contained in this paragraph. (j)(3)(vi)		
Chelation. (j)(4)		
Are precautions taken to assure that any person whom the employer retains, employs, supervises or controls does not engage in prophylactic chelation of any employee at any time? (j)(4)(i)		

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	YES	NO
If therapeutic or diagnostic chelation is to be performed, is it done only under the supervision of a licensed physician in a clinical setting, with thorough and appropriate medical monitoring, and only provided the employee was notified in writing prior to its occurrence? (j)(4)(ii)		
(k) **Medical Removal Protection.** (k)		
Are temporary removals due to elevated blood lead levels effected in accordance with the following? (k)(1)(i)		
During the first year of the standard (24/Feb/79 – 23/Feb/80), the employer shall remove an employee from work having a daily 8-hour TWA exposure to lead at or above 100μg/m^3, on each occasion that a periodic and a follow-up blood sampling test indicates that the employee's blood lead level is at or above 80μg/100g of whole blood. (k)(1)(i)(A)		
During the second year of the standard (24/Feb/80 – 23/Feb/81), the employer shall remove an employee from work having a daily 8-hour TWA exposure to lead at or above 50μg/m^3, on each occasion that a periodic and a follow-up blood sampling test indicates that the employee's blood lead level is at or above 70μg/100g of whole blood. (k)(1)(i)(B)		
Beginning with the third year of the standard (24/Feb/81), the employer shall remove an employee from work having an exposure to lead at or above the action level (30μg/m^3) on each occasion that a periodic and a follow-up blood sampling test indicates that the employee's blood lead level is at or above 60μg/100g of whole blood. (k)(1)(i)(C)		
Beginning with the fifth year of the standard (24/Feb/83), the employer shall remove an employee from work having an exposure to lead at or above the action level, on each occasion that the average of the last three blood sampling tests (or the average of all blood sampling tests conducted over the previous six months, whichever is longer) indicates that the employee's blood lead level is at or above 50μg/100g of whole blood; provided, however, that an employee need not be removed if the last blood sampling test indicates a blood level at or below 40μg/100g of whole blood. (k)(1)(i)(D)		
Are temporary removals due to a final medical determination effected in accordance with the following? (k)(1)(ii)		
An employee shall be removed from work having an exposure to lead at or above the action level on each occasion that a final medical determination results in a medical finding, determination, or opinion that the employee has a detected medical condition which places the employee at increased risk of material impairment to health from exposure to lead. (k)(1)(ii)(A)		
The phrase "final medical determination" shall mean the outcome of the multiple physician review mechanism or alternate medical determination mechanism used pursuant to the medical surveillance provisions of (j). (k)(1)(ii)(B)		

	YES	NO
Where a final medical determination results in any recommended special protective measures for an employee, or limitations on an employee's exposure to lead, the employer shall implement and act consistent with the recommendation. (k)(1)(ii)(C)		
Are employees returned to their former job status in accordance with the following? (k)(1)(iii)(A)		
For an employee removed due to the blood lead level at or above 80μg/100g, when two consecutive blood sampling tests indicate that the employee's blood lead level is at or below 60μg/100g of whole blood.		
For an employee removed due to a blood lead level at or above 70μg/100g, when two consecutive blood sampling tests indicate that the employee's blood lead level is at or below 50μg/100g of whole blood.		
For an employee removed due to a blood lead level at or above 60μg/100g, or due to an average blood lead level at or above 50μg/100g, when two consecutive blood sampling tests indicate that the employee's blood lead level is at or below 40μg/100g of whole blood.		
For an employee removed due to a final medical determination, when a subsequent final medical determination results in a medical finding, determination, or opinion that the employee no longer has a detected medical condition which places the employee at increased risk of material impairment to health from exposure to lead.		
NOTE: The requirement that an employer return an employee to his or her former job status is not intended to expand upon or restrict any rights an employee has or would have had, absent temporary medical removal, to a specific job classification or position under the terms of a collective bargaining agreement. (k)(1)(iii)(B)		
Does the employer remove any limitations placed on an employee, or end any special protective measures provided to an employee pursuant to a final medical determination, when a subsequent final medical determination indicates that the limitations or special protective measures are no longer necessary? (k)(1)(iv)		
Is the following complied with when the multiple physician review mechanism, or alternate medical determination mechanism, has not yet resulted in a final medical determination of an employee? (k)(1)(v)		
Removal – The employer may remove the employee from exposure to lead, provide special protective measures to the employee, or place limitations upon the employee, consistent with the medical findings, determinations, or recommendations of any of the physicians who have reviewed the employee's health status. (k)(1)(v)(A)		
Return – The employer may return the employee to his or her former job status, end any special protective measures provided to the employee, and remove any limitations placed upon the employee, consistent with the medical findings, determinations, or recommendations of any of the physicians who have reviewed the employee's health status, with two exceptions: (k)(1)(v)(B)		

	YES	NO
(1) The initial removal, special protection, or limitation of the employee resulted from a final medical determination which differed from the findings, determination, or recommendations of the initial physician, or		
(2) The employee has been on removal status for the preceding 18 months due to an elevated blood lead level, then the employer shall await a final medical determination.		
Medical Removal Protection Benefits. (k)(2)		
Are employees provided up to 18 months of medical removal protection benefits on each occasion that an employee is removed from exposure to lead or otherwise limited pursuant to this section? (k)(2)(i)		
NOTE: *(1) Medical removal protection benefits means that the employer shall maintain the earnings, seniority and other employment rights and benefits of an employee as though the employee had not been removed from normal exposure to lead or otherwise limited.* (k)(2)(ii)		
(2) During the period of time that an employee is removed from normal exposure to lead or otherwise limited, the employer may condition the provision of medical removal protection benefits upon the employee's participation in follow-up medical surveillance. (k)(2)(iii)		
If a removed employee files a claim for workers' compensation payments for a lead-related disability, are medical removal protection benefits continued pending disposition of the claim? (k)(2)(iv)		
NOTE: The employer's obligation to provide medical removal protection benefits to a removed employee shall be reduced to the extent that:		
(1) The employee receives a workers' compensation award for earnings lost during the period of removal; however, no credit is allowed for payments of treatment-related expenses. (k)(2)(iv)		
(2) The employee receives compensation for earnings lost during the period of removal either from a publicly or employer-funded compensation program, or receives income from employment with another employer made possible by virtue of the employee's removal. (k)(2)(v)		
Are the following measures taken for those employees whose blood lead levels do not adequately decline within 18 months of removal: (k)(2)(vi)		
Make available to the employee a medical examination pursuant to this section to obtain a final medical determination? (k)(2)(vi)(A)		
Assure that the final medical determination indicates whether or not the employee may be returned to his or her former job status, and if not, what steps should be taken to protect the employee's health? (k)(2)(vi)(B)		
Where the final medical determination has not yet been obtained, or, once obtained, indicates that the employee may not yet be returned to former job status; continue to provide medical removal protection benefits		

	YES	NO
to the employee until either the employee is returned to former job status, or a final medical determination is made that the employee is incapable of ever safely returning to his or her former job status? (k)(2)(vi)(C)		
NOTE: Where the employer acts pursuant to a final medical determination which permits the return of the employee to his or her former job status despite what would otherwise be an unacceptable blood lead level, later questions concerning removing the employee again shall be decided by a final medical determination. The employer need not automatically remove such an employee pursuant to the blood lead level removal criteria of this section. (k)(2)(vi)(D)		
Are medical removal protection benefits provided when an employer voluntarily removes or restricts an employee due to the effects of lead exposure? (k)(2)(vii)		
(l) **Employee Information and Training.** (l)		
Are employees who may be exposed to any level of airborne lead informed of the contents of Appendices A, B, and C*? (l)(1)(i)		
Has a training program been instituted and participation assured of all employees who are subject to exposure to lead at or above the action level, or for whom the possibility of skin or eye irritation exists? (l)(1)(ii)		
Has initial training been accomplished by August 28, 1979 for those employees exposed on the effective date of this standard? (l)(1)(iii)		
Is training provided prior to job assignment for employees initially exposed after the effective date of this standard (March 1, 1979)? (l)(1)(iii)		
Is the training program repeated at least annually for each employee? (l)(1)(iv)		
Is each employee informed of the following: (l)(1)(v)		
Content of this standard and of Appendices A, B, and C*? (l)(1)(v)(A)		
Specific nature of the operations which could result in exposure to lead above the action level? (l)(1)(v)(B)		
Purpose, proper selection, fitting, use and limitations of respirators? (l)(1)(v)(C)		
The purpose and a description of the medical surveillance program, and the medical removal protection program, including information concerning the adverse health effects associated with excessive exposure to lead (with particular attention to the adverse reproductive effects on both males and females)? (l)(1)(v)(D)		
Engineering controls and work practices associated with the employee's job assignment? (l)(1)(v)(E)		
Contents of any compliance plan in effect? (l)(1)(v)(F)		
Instructions to employees that chelating agents should not routinely be used to remove lead from their bodies, and should not be used at all except under the direction of a licensed physician? (l)(1)(v)(G)		
Is a copy of this standard and its appendices made readily available to all affected employees? (l)(2)(i)		

*See Self-Inspection Appendix

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	YES	NO
Are all materials relating to the employee information and training program provided, upon request, to the Assistant Secretary of Labor and the Director of NIOSH? (l)(2)(ii)		
Are any materials pertaining to the Occupational Safety and Health Act, the regulations issued pursuant to that Act, and this lead standard, which are made available to the employer by the Assistant Secretary of Labor, included as part of the training program and distributed to employees? (l)(2)(iii)		
(m) **Signs.** (m)		
NOTE: Employers may use signs required by other statutes, regulations or ordinances in addition to, or in combination with, signs required herein. (m)(1)(i)		
Are precautions taken to assure that no statement appears on or near any sign required by this paragraph which contradicts or detracts from the meaning of the required sign? (m)(1)(ii)		
Are the following warning signs posted in each work area where the permissible exposure limit (PEL) is exceeded? (m)(2)(i)		
WARNING LEAD WORK AREA POISON NO SMOKING OR EATING		
Are signs illuminated and cleaned as necessary so that the legend is readily visible? (m)(2)(ii)		
(n) **Recordkeeping.** (n)		
Exposure Monitoring. (n)(1)		
Has an accurate record been established and maintained of all monitoring required by (d), and does it include the following: (n)(1)(i)		
The date(s), number, duration, location and results of each of the samples taken, including a description of the sampling procedure used to determine representative employee exposure where applicable? (n)(1)(ii)(A)		
A description of the sampling and analytical methods used and evidence of their accuracy? (n)(1)(ii)(B)		
The type of respiratory protection devices worn, if any? (n)(1)(ii)(C)		
Name, social security number and job classification of the employee monitored, and of all other employees whose exposure the measurement is intended to represent? (n)(1)(ii)(D)		
The environmental variables that could affect the measurement of employee exposure? (n)(1)(ii)(D)		
Are the monitoring records maintained for at least 40 years, or for the duration of employment plus 20 years, whichever is longer? (n)(1)(iii)		
Medical Surveillance. (n)(2)		

*Appendices A, B and C appear in the Self-Inspection Appendix

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	YES	NO
Has an accurate record been established and maintained for each employee subject to medical surveillance as required by (j), and does it include the following: (n)(2)(i)		
Name, social security number, and description of the duties of the employee? (n)(2)(ii)(A)		
A copy of the physician's written opinions? (n)(2)(ii)(B)		
Results of any airborne exposure monitoring done for that employee, and the representative exposure levels supplied to the physician? (n)(2)(ii)(C)		
Any employee medical complaints related to exposure to lead? (n)(2)(ii)(D)		
Does the employer keep, or has he assured that the examining physician keeps, the following medical records: (n)(2)(iii)		
A copy of the medical examination results including medical and work history required under (j)? (n)(2)(iii)(A)		
A description of the laboratory procedures and a copy of any standards or guidelines used to interpret the test results, or references to that information? (n)(2)(iii)(B)		
A copy of the results of biological monitoring? (n)(2)(iii)(C)		
Are the required medical records maintained for at least 40 years, or for the duration of employment plus 20 years, whichever is longer? (n)(2)(iv)		
Medical Removals. (n)(3)		
Has an accurate record been established and maintained for each employee removed from current exposure to lead pursuant to (k), and does it include the following: (n)(3)(i)		
Name and social security number of the employee? (n)(3)(ii)(A)		
The date on each occasion that the employee was removed from current exposure to lead, as well as the corresponding date on which the employee was returned to his or her former job status? (n)(3)(ii)(B)		
A brief explanation of how each removal was or is being accomplished? (n)(3)(ii)(C)		
A statement with respect to each removal indicating whether or not the reason for the removal was an elevated blood lead level? (n)(3)(ii)(D)		
Is each medical removal record maintained for at least the duration of an employee's employment? (n)(3)(iii)		
Availability. (n)(4)		
Are all records required by (n) made available, upon request, to the Assistant Secretary of Labor and the Director of NIOSH for examination and copying? (n)(4)(i)		
Are the records of environmental monitoring, biological monitoring and medical removal made available, upon request, to affected employees, former employees or their authorized employee representatives for inspection and copying? (n)(4)(ii)		

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	YES	NO
Are employee medical records required by this standard made available, upon request, to the affected employee or former employee, or to a physician or other individual designated by such affected employee or former employee for examination and copying? **(n)(4)(iii)**		
Transfer of Records. **(n)(5)**		
Has the following been accomplished when an employer ceases to do business?		
The successor employer shall receive and retain all records required to be maintained by (n). **(n)(5)(i)**		
When there is no successor employer to receive and retain the records for the prescribed period, they shall be transmitted to the Director of NIOSH. **(n)(5)(ii)**		
Is the Director of NIOSH notified three months prior to disposal of required records which have met the mandatory retention period, and are such records transmitted to the Director if he requests them within the three-month period? **(n)(5)(iii)**		
(o) **Observation of Monitoring.** **(o)**		
Are affected employees, or their designated representatives, provided an opportunity to observe any monitoring of employee exposure to lead conducted pursuant to (d)? **(o)(1)**		

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	YES	NO
Are observers provided necessary personal protective equipment, and is the use of such equipment and compliance with all other applicable safety and health procedures assured, when entering areas where the use of such personal protective equipment is required? **(o)(2)(i)**		
Without interfering with the measurement, are observers entitled to: **(o)(2)(ii)**		
Receive an explanation of the measurement procedures? **(o)(2)(ii)(A)**		
Observe all steps related to the monitoring of lead performed at the place of exposure? **(o)(2)(ii)(B)**		
Record the results obtained or receive copies of the results when returned by the laboratory? **(o)(2)(ii)(C)**		
(q) **Appendices.** **(q)**		
The information contained in Appendices A, B and C* is not intended, by itself, to create any additional obligations not otherwise imposed by this standard, nor to detract from any existing obligation.		

*Appendices A, B and C appear in the Self-Inspection Appendix

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YES	NO

(a) Scope

This standard applies to all occupational exposures to cadmium and cadmium compounds, in all forms, and in all industries covered by the Occupational Safety and Health Act, except the construction-related industries, which are covered under 29 CFR 1926-63.

Definitions

See page Z-iii

(c) Permissible Exposure Limit (PEL)

Does the employer assure that no employee is exposed to an airborne concentration of cadmium in excess of five micrograms per cubic meter of air (5 μg/m3), calculated as an eight-hour time-weighted average exposure (TWA)? **(c)**

(d) Exposure Monitoring

General

Does each employer who has a workplace or work operation covered by this section determine if any employee may be exposed to cadmium at or above the action level? **(d)(1)(i)**

Are determinations of employee exposure made from breathing zone air samples that reflect the monitored employee's regular, daily 8-hour TWA exposure to cadmium? **(d)(1)(ii)**

Is the eight-hour TWA exposure determined for each employee on the basis of one or more personal breathing zone air samples reflecting full shift exposure on each shift, for each job classification, in each work area? **(d)(1)(iii)**

Where several employees perform the same job tasks, in the same job classification, on the same shift, in the same work area, and the length, duration, and level of cadmium exposures are similar, does the employer sample a representative fraction of the employees instead of all employees in order to meet this requirement? **(d)(1)(iii)**

In representative sampling, does the employer sample the employee(s) expected to have the highest cadmium exposures? **(d)(1)(iii)**

Specific

Initial monitoring. Except as provided for in paragraphs (d)(2)(ii) and (d)(2)(iii) of this section, does the employer monitor employee exposure and base initial determinations on the monitoring results? **(d)(2)(i)**

Where the employer has monitored after September 14, 1991, under conditions that in all important aspects closely resemble those currently prevailing and where the monitoring satisfies all other requirements of this section, including the accuracy and confidence levels of paragraph (d)(6) of this section, does the employer rely on such earlier monitoring results to satisfy the requirements of paragraph (d)(2)(i) of this section? **(d)(2)(ii)**

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YES	NO

Where the employer has objective data, as defined in paragraph (n)(2) of this section, demonstrating that employee exposure to cadmium will not exceed the action level under the expected conditions of processing, use, or handling, does the employer rely upon such data instead of implementing initial monitoring? **(d)(2)(iii)**

Monitoring Frequency (periodic monitoring)

If the initial monitoring or periodic monitoring reveals employee exposures to be at or above the action level, does the employer monitor at a frequency and pattern needed to represent the levels of exposure of employees and where exposures are above the PEL to assure the adequacy of respiratory selection and the effectiveness of engineering and work practice controls? **(d)(3)(i)**

Is such exposure monitoring performed at least every six months? **(d)(3)(i)**

Does the employer, at a minimum, continue these semi-annual measurements unless and until the conditions set out in paragraph (d)(3)(ii) of this section are met? **(d)(3)(i)**

If the initial monitoring or the periodic monitoring indicates that employee exposures are below the action level and that result is confirmed by the results of another monitoring taken at least seven days later, does the employer discontinue the monitoring for those employees whose exposures are represented by such monitoring? **(d)(3)(ii)**

Additional Monitoring

Does the employer also institute the exposure monitoring required under paragraphs (d)(2)(i) and (d)(3) of this section whenever there has been a change in the raw materials, equipment, personnel, work practices, or finished products that may result in additional employees being exposed to cadmium at or above the action level or in employees already exposed to cadmium at or above the action level being exposed above the PEL, or whenever the employer has any reason to suspect that any other change might result in such further exposure? **(d)(4)**

Employee Notification of Monitoring Results

Within 15 working days after the initial receipt of the results of any monitoring performed under this section, does the employer notify each affected employee individually in writing of the results? **(d)(5)(i)**

In addition, within the same time period does the employer post the results of the exposure monitoring in an appropriate location that is accessible to all affected employees? **(d)(5)(i)**

Wherever monitoring results indicate that employee exposure exceeds the PEL, does the employer include in the written notice a statement that the PEL has been exceeded and a description of the corrective action being taken by the employer to reduce employee exposure to or below PEL? **(d)(5)(ii)**

YES	NO

Accuracy of Measurement

Does the employer use a method of monitoring and analysis that has an accuracy of not less than plus or minus 25 percent (± 25%), with a confidence level of 95 percent, for airborne concentrations of cadmium at or above the action level, the permissible exposure limit (PEL), and the separate engineering control air limit (SECAL)? **(d)(6)**

(e) Regulated Areas

Establishment

Does the employer establish a regulated area wherever an employee's exposure to airborne concentrations of cadmium is, or can reasonably be expected to be in excess of the permissible exposure limit (PEL)? **(e)(1)**

Demarcation

Are regulated areas demarcated from the rest of the workplace in any manner that adequately establishes and alerts employees of the boundaries of the regulated area? **(e)(2)**

Access

Is access to regulated areas limited to authorized persons? **(e)(3)**

Provision of Respirators

Is each person entering a regulated area supplied with and required to use a respirator, selected in accordance with paragraph (g)(2) of this section? **(e)(4)**

Prohibited Activities

Does the employer assure that employees do not eat, drink, smoke, chew tobacco or gum, or apply cosmetics in regulated areas, carry the products associated with these activities into regulated areas, or store such products in those areas? **(e)(5)**

(f) Methods of Compliance

Compliance Hierarchy

Except as specified in paragraphs (f)(1)(ii), (iii) and (iv) of this section does the employer implement engineering and work practice controls to reduce and maintain employee exposure to cadmium at or below the PEL, except to the extent that the employer can demonstrate that such controls are not feasible? **(f)(1)(i)**

Except as specified in paragraphs (f)(1)(iii) and (iv) of this section, in industries where a separate engineering control air limit (SECAL) has been specified for particular processes (See Table 1 in this paragraph (f)(1)(ii)), does the employer implement engineering and work practice controls to reduce and maintain employee exposure at or below the SECAL, except to the extent that the employer can demonstrate that such controls are not feasible? **(f)(1)(ii)**

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YES	NO

TABLE 1 – SEPARATE ENGINEERING CONTROL AIRBORNE LIMITS (SECALS) FOR PROCESSES IN SELECTED INDUSTRIES

Industry	Process	SECAL ($\mu g/m^3$)
Nickel cadmium battery	Plate making, plate preparation	50
	All other processes	15
Zinc/Cadmium refining*	Cadmium refining, casting, melting, oxide production, sinter plant	50
Pigment manufacture	Calcine, crushing, milling, blending	50
	All other processes	15
Stabilizers*	Cadmium oxide charging, crushing, drying, blending	50
Lead smelting*	Sinter plant, blast furnace, baghouse, yard area	50
Plating*	Mechanical plating	15

*Processes in these industries that are not specified in this table must achieve the PEL using engineering controls and work practices as required in (f)(1)(i)

Does the requirement to implement engineering and work practice controls to achieve the PEL or, where applicable, the SECAL not apply where the employer demonstrates the following: **(f)(1)(iii)**

- The employee is only intermittently exposed; **(f)(1)(iii)(A)**
- The employee is not exposed above the PEL on 30 or more days per year (12 consecutive months)? **(f)(1)(iii)(B)**

Wherever engineering and work practice controls are required and are not sufficient to reduce employee exposure to or below the PEL or, where applicable, the SECAL, does the employer nonetheless implement such controls to reduce exposures to the lowest levels achievable? **(f)(1)(iv)**

Does the employer supplement such controls with respiratory protection that complies with the requirements of paragraph (g) of this section and the PEL? **(f)(1)(iv)**

Does the employer not use employee rotation as a method of compliance? **(f)(1)(v)**

Compliance Program

Where the PEL is exceeded, does the employer establish and implement a written compliance program to reduce employee exposure to or below the PEL by means of engineering and work practice controls, as required by paragraph (f)(1) of this section? **(f)(2)(i)**

To the extent that engineering and work practice controls cannot reduce exposures to or below the PEL, does the employer include in the written compliance program the use of appropriate respiratory protection to achieve compliance with the PEL? **(f)(2)(i)**

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	YES	NO
Do written compliance programs include at least the following: (f)(2)(ii)		
• A description of each operation in which cadmium is emitted; e.g., machinery used, material processed, controls in place, crew size, employee job responsibilities, operating procedures, and maintenance practices; (f)(2)(ii)(A)		
• A description of the specific means that will be employed to achieve compliance, including engineering plans and studies used to determine methods selected for controlling exposure to the use of appropriate respiratory protection to achieve the PEL; (f)(2)(ii)(B)		
• A report of the technology considered in meeting the PEL; (f)(2)(ii)(C)		
• Air monitoring data that document the sources of cadmium emissions; (f)(2)(ii)(D)		
• A detailed schedule for implementation of the program, including documentation such as copies of purchase orders for equipment, construction contracts, etc.; (f)(2)(ii)(E)		
• A work practice program that includes items required under paragraph (h), (i), and (j) of this section; (f)(2)(ii)(F)		
• A written plan for emergency situations, as specified in paragraph (h) of this section; (f)(2)(ii)(G)		
AND		
• Other relevant information? (f)(2)(ii)(H)		
Are the written compliance programs reviewed and updated at least annually, or more often if necessary, to reflect significant changes in the employer's compliance status? (f)(2)(iii)		
Are written compliance programs provided upon request for examination and copying to affected employees, designated employee representatives as well as to the Assistant Secretary, and the Director? (f)(2)(iv)		
Mechanical Ventilation		
When ventilation is used to control exposure, are measurements that demonstrate the effectiveness of the system in controlling exposure, such as capture velocity, duct velocity, or static pressure made as necessary to maintain its effectiveness? (f)(3)(i)		
Are measurements of the system's effectiveness in controlling exposure made as necessary within five working days of any change in production, process, or control that might result in a significant increase in employee exposure to cadmium? (f)(3)(ii)		
Recirculation of Air.		
If air from exhaust ventilation is recirculated into the workplace, does the system have a high efficiency filter that is monitored to assure effectiveness? (f)(3)(iii)		

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	YES	NO
Are procedures developed and implemented to minimize employee exposure to cadmium when maintenance of ventilation systems and changing of filters is being conducted? (f)(3)(iv)		
[Deleted] (f)(4)		
(g) Respirator Protection		
General		
Where respirators are required by this section, does the employer provide them at no cost to the employee and assure that they are used in compliance with the requirements of this section? (g)(1)		
Are respirators used in the following circumstances: (g)(1)		
• Where exposure levels exceed the PEL, during the time period necessary to install or implement feasible engineering and work practice controls; (g)(1)(i)		
• In those maintenance and repair activities and during those brief or intermittent operations where exposures exceed the PEL and engineering and work practice controls are not feasible or are not required; (g)(1)(ii)		
• In regulated areas, as prescribed in paragraph (e) of this section; (g)(1)(iii)		
• Where the employer has implemented all feasible engineering and work practice controls and such controls are not sufficient to reduce exposures to or below the PEL; (g)(1)(iv)		
• In emergencies; (g)(1)(v)		
• Wherever an employee who is exposed to cadmium at or above the action level requests a respirator; (g)(1)(vi)		
• Wherever an employee is exposed above the PEL in an industry to which a SECAL is applicable; (g)(1)(vii)		
AND		
• Wherever an employee is exposed to cadmium above the PEL and engineering controls are not required under paragraph (f)(1)(iii) of this section? (g)(1)(viii)		
Respirator Selection		
Where respirators are required under this section, does the employer select and provide the appropriate respirator as specified in Table 2 in this paragraph (g)(2)(i)? (g)(2)(i)		
Does the employer select respirators form among those jointly approved as acceptable protection against cadmium dust, fume, and mist by the Mine Safety and Health Administration (MSHA) and by the National Institute for Occupational Safety and Health (NIOSH) under the provisions of 30 CFR part 11? (g)(2)(i)		

YES | NO

TABLE 2–RESPIRATORY PROTECTION FOR CADMIUM

Airborne concentration or condition of use[a]	Required respirator type[b]
10 × or less	A half mask, air-purifying respirator equipped with a HEPA[c] filter.[d]
25 × or less	A powered air-purifying respirator ("PAPR") with a loose-fitting hood or helmet equipped with a HEPA filter, or a supplied-air respirator with a loose-fitting hood or helmet facepiece operated in the continuous flow mode.
50 × or less	A full facepiece air-purifying respirator equipped with a HEPA filter, or a powered air-purifying respirator with a tight-fitting half mask equipped with a HEPA filter, or a supplied air respirator with a tight-fitting half mask operated in the continuous flow mode.
250 × or less	A powered air-purifying respirator with a tight-fitting full facepiece equipped with a HEPA filter, or a supplied-air respirator with a tight-fitting full facepiece operated in the continuous flow mode.
1000 × or less	A supplied-air respirator with half mask or full facepiece operated in the pressure demand or other positive pressure mode.
>1000 × or unknown concentrations	A self-contained breathing apparatus with a full facepiece operated in the pressure demand or other positive pressure mode, or a supplied-air respirator with a full facepiece operated in the pressure demand or other positive pressure mode and equipped with an auxiliary escape type self-contained breathing apparatus operated in the pressure demand mode.
Fire fighting	A self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

[a]Concentrations expressed as multiple of the PEL.
[b]Respirators assigned for higher environmental concentrations may be used at lower exposure levels. Quantitative fit testing is required for all tight-fitting air purifying respirators where airborne concentration of cadmium exceeds 10 times the TWA PEL ($10 \times 5\ \mu g/m^3 = 50\ \mu g/m^3$). A full facepiece respirator is required when eye irritation is experienced.
[c]HEPA means High Efficiency Particulate Air.
[d]Fit testing, quantitative, is required.

SOURCE: Respiratory Decision Logic, NIOSH, 1987

Does the employer provide a powered, air-purifying respirator (PAPR) in lieu of a negative pressure respirator wherever: **(g)(2)(ii)**

- An employee entitled to a respirator chooses to use this type of respirator; **(g)(2)(ii)(A)**
- This respirator will provide adequate protection to the employee; **(g)(2)(ii)(B)**

Respirator Program

Where respiratory protection is required, does the employer institute a respirator protection program in accordance with 29 CFR 1910 134? **(g)(3)(i)**

Does the employer permit each employee who is required to use an air purifying respirator to leave the regulated area to change the filter elements or replace the respirator whenever an increase in breathing resistance is detected and maintain an adequate supply of filter elements for this purpose? **(g)(3)(ii)**

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YES | NO

Does the employer also permit each employee who is required to wear a respirator to leave the regulated area to wash his or her face and the respirator facepiece whenever necessary to prevent skin irritation associated with respirator use? **(g)(3)(iii)**

If an employee exhibits difficulty in breathing while wearing a respirator during a fit test or during use, does the employer make available to the employee a medical examination in accordance with paragraph (l)(6)(ii) of this section to determine if the employee can wear a respirator while performing the required duties? **(g)(3)(iv)**

Is no employee assigned a task requiring the use of a respirator if, based upon his or her most recent examination, an examining physician determines that the employee will be unable to continue to function normally while wearing a respirator? **(g)(3)(v)**

If the physician determines the employee must be limited in, or removed from his or her current job because of the employee's inability to wear a respirator, is the limitation or removal in accordance with paragraphs (l)(11) and (12) of this section? **(g)(3)(v)**

Respirator Fit Testing

Does the employer assure that the respirator issued to the employee is fitted properly and exhibits the least possible facepiece leakage? **(g)(4)(i)**

For each employee wearing a tight-fitting, air purifying respirator (either negative or positive pressure) who is exposed to airborne concentrations of cadmium that do not exceed 10 times the PEL ($10 \times 5\ \mu g/m^3 = 50\ \mu g/m^3$), does the employer perform either quantitative or qualitative fit testing at the time of initial fitting and at least annually thereafter? **(g)(4)(ii)**

If quantitative fit testing is used for a negative pressure respirator, is a fit factor that is at least 10 times the protection factor for that class of respirator (Table 2 in paragraph (g)(2)(i) of this section) achieved at testing? **(g)(4)(ii)**

For each employee wearing a tight-fitting air purifying respirator (either negative or positive pressure) who is exposed to airborne concentrations of cadmium that exceed 10 times the PEL ($10 \times 5\ \mu g/m^3 = 50\ \mu g/m^3$), does the employer perform quantitative fit testing at the time of initial fitting and at least annually thereafter? **(g)(4)(iii)**

For negative-pressure respirators, is a fit factor that is at least 10 times the protection factor for that class of respirators (Table 2 in paragraph (g)(2)(i) of this section), achieved during quantitative fit testing? **(g)(4)(iii)**

For each employee wearing a tight-fitting, supplied-air respirator or self-contained breathing apparatus, does the employer perform quantitative fit testing at the time of initial fitting and at least annually thereafter? **(g)(4)(iv)**

Is this accomplished by fit testing an air purifying respirator of identical type facepiece, make, model, and size as the supplied air respirator or self-contained breathing apparatus that is equipped with HEPA filters and tested as a surrogate (substitute) in the negative pressure mode? **(g)(4)(iv)**

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	YES	NO
Is a fit factor that is at least 10 times the protection factor for that class of respirators (Table 2 in paragraph (g)(2)(i) of this section) achieved during quantitative fit testing? **(g)(4)(iv)**		
Is a supplied-air respirator or self-contained breathing apparatus with the same type facepiece, make, model, and size as the air purifying respirator with which the employee passed the quantitative fit test then used by that employee up to the protection factor listed in Table 2 for the class of respirators? **(g)(4)(iv)**		
Is fit testing conducted in accordance with appendix C of this section? **(g)(4)(v)**		
(h) Emergency Situations		
Does the employer develop and implement a written plan for dealing with emergency situations involving substantial releases of airborne cadmium? **(h)**		
Does the plan include provisions for the use of appropriate respirators and personal protective equipment? **(h)**		
In addition, are employees not essential to correcting the emergency situation restricted from the area and normal operations halted in that area until the emergency is abated? **(h)**		
(i) Protective Work Clothing and Equipment		
Provision and Use		
If an employee is exposed to airborne cadmium above the PEL or where skin or eye irritation is associated with cadmium exposure at any level, does the employer provide at no cost to the employee, and assure that the employee uses, appropriate protective work clothing and equipment that prevents contamination of the employee and the employee's garments? **(i)(1)**		
Does protective work clothing and equipment include, while not being limited to: **(i)(1)**		
• Coveralls or similar full-body work clothing; **(i)(1)(i)**		
• Gloves, head coverings, and boots or foot coverings; **(i)(1)(ii)**		
AND		
• Face shields, vented goggles, or other appropriate protective equipment that complies with 29 CFR 1910.133? **(i)(1)(iii)**		
Removal and Storage		
Does the employer assure that employees remove all protective clothing and equipment contaminated with cadmium at the completion of the work shift and do so only in change rooms provided in accordance with paragraph (j)(1) of this section? **(i)(2)(i)**		
Does the employer assure that no employee takes cadmium-contaminated protective clothing or equipment from the workplace, except for employees authorized to do so for purposes of laundering, cleaning, maintaining, or disposing of cadmium contaminated protective clothing and equipment at an appropriate location or facility away from the workplace? **(i)(2)(ii)**		

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	YES	NO
Does the employer assure that contaminated protective clothing and equipment, when removed for laundering, cleaning, maintenance, or disposal, is placed and stored in sealed, impermeable bags or other closed, impermeable containers that are designed to prevent dispersion of cadmium dust? **(i)(2)(iii)**		
Does the employer assure that bags or containers of contaminated protective clothing and equipment that are to be taken out of the change rooms or the workplace for laundering, cleaning, maintenance or disposal bear labels in accordance with paragraph (m)(3) of this section? **(i)(2)(iv)**		
Cleaning, Replacement, and Disposal		
Does the employer provide the protective clothing and equipment required by paragraph (i)(1) of this section in a clean and dry condition as often as necessary to maintain its effectiveness, but in any event at least weekly? **(i)(3)(i)**		
Is the employer responsible for cleaning and laundering the protective clothing and equipment required by this paragraph to maintain its effectiveness and also for disposing of such clothing and equipment? **(i)(3)(i)**		
Is the employer also responsible for repairing or replacing required protective clothing and equipment as needed to maintain its effectiveness? **(i)(3)(ii)**		
When rips or tears are detected while an employee is working are they be immediately mended, or the work suit immediately replaced? **(i)(3)(ii)**		
Does the employer prohibit the removal of cadmium from protective clothing and equipment by blowing, shaking, or any other means that disperses cadmium into the air? **(i)(e)(iii)**		
Does the employer assure that any laundering of contaminated clothing or cleaning of contaminated equipment in the workplace is done in a manner that prevents the release of airborne cadmium in excess of the permissible exposure limit prescribed in paragraph (c) of this section? **(i)(3)(iv)**		
Does the employer inform any person who launders or cleans protective clothing or equipment contaminated with cadmium of the potentially harmful effects of exposure to cadmium and that the clothing and equipment should be laundered or cleaned in a manner to effectively prevent the release of airborne cadmium in excess of the PEL? **(i)(3)(v)**		
(j) Hygiene Areas and Practices		
General		
For employees whose airborne exposure to cadmium is above the PEL, does the employer provide clean change rooms, hand washing facilities, showers, and lunchroom facilities that comply with 29 CFR 1910.141? **(j)(1)**		
Change Rooms		
Does the employer assure that change rooms are equipped with separate storage facilities for street clothes and for protective clothing and equipment, which are designed to prevent dispersion of cadmium and contamination of the employee's street clothes? **(j)(2)**		

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	YES	NO

Showers and Hand Washing Facilities

Does the employer assure that employees who are exposed to cadmium above the PEL shower during the end of the work shift? **(j)(3)(i)**

Does the employer assure that employees whose airborne exposure to cadmium is above the PEL wash their hands and faces prior to eating, drinking, smoking, chewing tobacco or gum, or applying cosmetics? **(j)(3)(ii)**

Lunchroom Facilities

Does the employer assure that the lunchroom facilities are readily accessible to employees, that tables for eating are maintained free of cadmium, and that no employee in a lunchroom facility is exposed at any time to cadmium at or above a concentration of 2.5 $\mu g/m^3$? **(j)(4)(i)**

Does the employer assure that employees do not enter lunchroom facilities with protective work clothing or equipment unless surface cadmium has been removed from the clothing and equipment by HEPA vacuuming or some other method that removes cadmium dust without dispersing it? **(j)(4)(ii)**

(k) Housekeeping

Are all surfaces maintained as free as practicable of accumulations of cadmium? **(k)(1)**

Are all spills and sudden releases of material containing cadmium cleaned up as soon as possible? **(k)(2)**

Are surfaces contaminated with cadmium cleaned, wherever possible, by vacuuming or other methods that minimize the likelihood of cadmium becoming airborne? **(k)(3)**

Is HEPA-filtered vacuuming equipment or equally effective filtration methods used for vacuuming? **(k)(4)**

Is the equipment used and emptied in a manner that minimizes the reentry of cadmium into the workplace? **(k)(4)**

Are shoveling, dry or wet sweeping, and brushing used only where vacuuming or other methods that minimize the likelihood of cadmium becoming airborne have been tried and found not to be effective? **(k)(5)**

Is compressed air not used to remove cadmium from any surface unless the compressed air is used in conjunction with a ventilation system designed to capture the dust cloud created by the compressed air? **(k)(6)**

Are waste, scrap, debris, bags, containers, personal protective equipment, and clothing contaminated with cadmium and consigned for disposal collected and disposed of in sealed impermeable bags or other closed, impermeable containers? Are these bags and containers labeled in accordance with paragraph (m)(2) of this section? **(k)(7)**

(l) Medical Surveillance

General

Scope

Does the employer institute a medical surveillance program for all employees who are or may be exposed to cadmium at or above the action level unless the employer demonstrates that the employee is not, and will not be, exposed at or above the action level on 30 or more days per year (twelve consecutive months)? **(l)(1)(i)(A)**

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	YES	NO

Does the employer also institute a medical surveillance program for all employees who prior to the effective date of this section might previously have been exposed to cadmium at or above the action level by the employer, unless the employer demonstrates that the employee did not prior to the effective date of this section work for the employer in jobs with exposure to cadmium for an aggregated total of more than 60 months? **(l)(1)(i)(B)**

To determine an employee's fitness for using a respirator, does the employer provide the limited medical examination specified in paragraph (l)(6) of this sections? **(l)(1)(ii)**

Does the employer assure that all medical examinations and procedures required by this standard are performed by or under the supervision of a licensed physician, who has read and is familiar with the health effects section of appendix A to this section, the regulatory text of this section, the protocol for sample handling and laboratory selection in appendix F to this section, and the questionnaire of appendix D to this section? **(l)(1)(iii)**

Are these examinations and procedures provided without cost to the employee and at a time and place that is reasonable and convenient to employees? **(l)(1)(iii)**

Does the employer assure that the collecting and handling of biological samples of cadmium in urine (CdU), cadmium in blood (CdB), and beta-2 microglobulin in urine (β_2-M) taken from employees under this section is performed in laboratories with demonstrated proficiency for that particular analyte? (See appendix F to this section.) **(l)(1)(iv)**

Initial Examination

Does the employer provide an initial (preplacement) examination to all employees covered by the medical surveillance program required in paragraph (l)(1)(i) of this section? **(l)(2)(i)**

Is the examination provided to those employees within 30 days after initial assignment to a job with exposure to cadmium or no later than 90 days after the effective date of this section, whichever date is later? **(l)(2)(i)**

Does the initial (preplacement) medical examination include: **(l)(2)(ii)**

- A detailed medical and work history, with emphasis on: Past, present, and anticipated future exposure to cadmium; any history of renal, cardiovascular, respiratory, hematopoietic, reproductive, and/or musculo-skeletal system dysfunction; current usage of medication with potential nephrotoxic side-effects; and smoking history and current status; **(l)(2)(ii)(A)**

AND

- Biological monitoring that includes the following tests: **(l)(2)(ii)(B)**
- Cadmium in urine (CdU), standardized to grams of creatine (g/Cr); **(l)(2)(ii)(B)(1)**
- Beta-2 microglobulin in urine (β_2-M), standardized to grams of creatinine (g/Cr), with pH specified, as described in appendix F to this section; **(l)(2)(ii)(B)(2)**

	YES	NO
• Cadmium in blood (CdB), standardized to liters of whole blood (lwb)? (I)(2)(ii)(B)(3)		
Recent Examination		
Is an initial examination not required to be provided if adequate records show that the employee has been examined in accordance with the requirements of paragraph (I)(2)(ii) of this section within the past 12 months? (I)(2)(iii)		
In that case, are such records maintained as part of the employee's medical record and the prior exam treated as if it were an initial examination for the purposes of paragraphs (I)(3) and (4) of this section? (I)(2)(iii)		
Actions Triggered by Initial Biological Monitoring		
If the results of the initial biological monitoring tests show the employee's CdU level to be at or below 3μg/g Cr, β_2-M level to be at or below 300 μg/g Cr and CdB level to be at or below 5 μg/lwb, then: (I)(3)(i)		
For currently exposed employees, who are subject to medical surveillance under paragraph (I)(1)(i)(A) of this section, does the employer provide the minimum level of periodic medical surveillance in accordance with the requirements in paragraph (I)(4)(i) of this section? (I)(3)(i)(A)		
For previously exposed employees, who are subject to medical surveillance, under paragraph (I)(1)(i)(B) of this section, does the employer provide biological monitoring for CdU, β_2-M, and CdB one year after the initial biological monitoring and then the employer shall comply with the requirements of paragraph (I)(4)(v) of this section? (I)(3)(i)(B)		
For all employees who are subject to medical surveillance under paragraph (I)(1)(i) of this section, if the results of the initial biological monitoring tests show the level of CdU to exceed 3 μg/g Cr, the level of β_2-M to exceed 300 μg/g Cr, or the level of CdB to exceed 5 μg/lwb, does the employer: (I)(3)(ii)		
Within two weeks after receipt of biological monitoring results, reassess the employee's occupational exposure to cadmium as follows: (I)(3)(ii)(A)		
• Reassess the employee's work practices and personal hygiene; (I)(3)(ii)(A)(1)		
• Reevaluate the employee's respirator use, if any, and the respirator program; (I)(3)(ii)(A)(2)		
• Review the hygiene facilities; (I)(3)(ii)(A)(3)		
• Reevaluate the maintenance and effectiveness of the relevant engineering controls; (I)(3)(ii)(A)(4)		
AND		
• Assess the employee's smoking history and status? (I)(3)(ii)(A)(5)		
Within 30 days after the exposure reassessment, specified in paragraph (I)(3)(ii)(A) of this section, does the employer take reasonable steps to correct any deficiencies found in the reassessment that may be responsible for the employee's excess exposure to cadmium? (I)(3)(ii)(B)		

	YES	NO
Within 90 days after receipt of biological monitoring results, does the employer provide a full medical examination to the employee in accordance with the requirements of paragraph (I)(3)(ii) of this section? (I)(3)(ii)(C)		
After completing the medical examination, does the examining physician determine in a written medical opinion whether to medically remove the employee? (I)(3)(ii)(C)		
If the physician determines that medical removal is not necessary, then until the employee's CdU levels falls to or below 3 μg/g Cr, and CdB level falls to or below 5 μg/lwb, does the employer: (I)(3)(ii)(C)		
• Provide biological monitoring in accordance with paragraph (I)(2)(ii)(B) on a semiannual basis; (I)(3)(ii)(C)(1)		
• Provide annual medical examinations in accordance with paragraph (I)(4)(ii) of this section? (I)(3)(ii)(C)(2)		
For all employees who are subject to medical surveillance under paragraph (I)(1)(i) of this section, if results of the initial biological monitoring tests show the level of CdU to be in excess of 15 μg/g Cr, or the level of CdB to be in excess of 15 μg/lwb, or the level of β_2-M to be in excess of 1,500 μg/g Cr, does the employer comply with the requirements of paragraphs (I)(3)(ii)(A)-(B) of this section? (I)(3)(iii)		
Within 90 days after receipt of biological monitoring results, does the employer provide a full medical examination to the employee in accordance with the requirements of paragraph (I)(4)(ii) of this section? (I)(3)(iii)		
After completing the medical examination, does the examining physician determine in a written medical opinion whether to medically remove the employee? (I)(3)(iii)		
However, if the initial biological monitoring results obtained during the medical examination both show that CdU exceeds 15 μg/g Cr; or CdB exceeds 15 μg/lwb; or β_2-M exceeds 1500 μg/g Cr, and in addition CdU exceeds 3 μg/g Cr or CdB exceeds 5 μg/ liter of whole blood, then does the physician medically remove the employee from exposure to cadmium at or above the action level? (I)(3)(iii)		
If the second set of biological monitoring results obtained during the medical examinations does not show that a mandatory removal trigger level has been exceeded, then is the employee not required to be removed by the mandatory provisions of this paragraph? (I)(3)(iii)		
If the employee is not required to be removed by the mandatory provisions of this paragraph or by the physician's determination, then until the employee's CdU level falls to or below 3 μg/g Cr, β_2-M level falls to or below 300/μg/g Cr and CdB level falls to or below 5 μg/lwb, does the employer: (I)(3)(iii)		
• Periodically reassess the employee's occupational exposure to cadmium; (I)(3)(iii)(A)		
• Provide biological monitoring in accordance with paragraph (I)(2)(ii)(B) of this section on a quarterly basis; (I)(3)(iii)(B)		
• Provide semiannual medical examinations in accordance with paragraph (I)(4)(ii) of this section? (I)(3)(iii)(C)		

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	YES	NO
For all employees to whom medical surveillance is provided, beginning on January 1, 1999, and in lieu of paragraphs (l)(3)(i)-(iii) of this section: **(l)(3)(iv)**		
If the results of the initial biological monitoring tests show the employee's CdU level to be at or below 3 μg/g Cr, β_2-M level to be at or below 300/μg/g Cr and CdB level to be at or below 5 μg/lwb, then for currently exposed employees, does the employer comply with the requirements of paragraph (l)(3)(i)(A) of this section, and for previously exposed employees, does the employer comply with the requirements of paragraph (l)(3)(i)(B) of this section? **(l)(3)(iv)(A)**		
If the results of the initial biological monitoring tests show the level of CdU to exceed 3 μg/g Cr, the level of β_2-M to exceed 300 μg/g Cr, or the level of CdB to exceed 5 μg/lwb, does the employer comply with the requirements of paragraphs (l)(3)(ii)(A)-(C) of this section? **(l)(3)(iv)(B)**		
If the results of the initial biological monitoring tests show the level of CdU to exceed 7 μg/g Cr, or the level of CdB to exceed 10 μg/lwb, or the level of β_2-M to exceed 750 μg/g Cr, does the employer comply with the requirements of paragraph (l)(3)(ii)(A)-(B) of this section; and, within 90 days after receipt of biological monitoring results, provide a full medical examination to the employee in accordance with the requirements of paragraph (l)(4)(ii) of this section? **(l)(3)(iv)(C)**		
After completing the medical examination, does the examining physician determine in a written medical opinion whether to medically remove the employee? **(l)(3)(iv)(C)**		
However, if the initial biological monitoring results and the biological monitoring results obtained during the medical examination both show that: CdU exceeds 7 μg/g Cr; or CdB exceeds 10 μg/lwb; or β_2-M exceeds 750 μg/g/Cr, and in addition CdU exceeds 3 μg/g Cr or CdB exceeds 5 μg/liter of whole blood, then does the physician medically remove the employee from exposure to cadmium at or above the action level? **(l)(3)(iv)(C)**		
If the second set of biological monitoring results obtained during the medical examination does not show that a mandatory removal trigger level has been exceeded, then is the employee not required to be removed by the mandatory provisions of this paragraph? **(l)(3)(iv)(C)**		
If the employee is not required to be removed by the mandatory provisions of this paragraph or by the physician's determination, then until the employee's CdU level falls to or below 3 μg/g Cr, β_2-M level falls to or below 300 μg/g Cr and CdB level falls to or below 5 μg/lwb, does the employer periodically reassess the employee's occupational exposure to cadmium; provide biological monitoring in accordance with paragraph (l)(2)(ii)(B) of this section on a quarterly basis; and provide semiannual medical examinations in accordance with paragraph (l)(4)(ii) of this section? **(l)(3)(iv)(C)**		
Periodic Medical Surveillance		
For each employee who is covered under paragraph (l)(1)(i)(A) of this section, does the employer provide at least the minimum level of periodic medical surveillance, which consists of periodic medical examinations and periodic biological monitoring? **(l)(4)(i)**		

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	YES	NO
Is a periodic medical examination provided within one year after the initial examination required by paragraph (l)(2) of this section and thereafter at least biennially? **(l)(4)(i)**		
Is biological sampling provided at least annually, either as part of a periodic medical examination or separately as periodic biological monitoring? **(l)(4)(i)**		
Does the periodic medical examination include: **(l)(4)(ii)**		
• A detailed medical and work history, or update thereof, with emphasis on: Past, present and anticipated future exposure to cadmium, smoking history and current status; reproductive history; current use of medications with potential nephrotoxic side-effects; any history of renal, cardiovascular, respiratory, hematopoietic, and/or musculo-skeletal system dysfunction; and as part of the medical and work history, for employees who wear respirator, questions 3-11 and 25-32 in Appendix D to this section; **(l)(4)(ii)(A)**		
• A complete physical examination with emphasis on: Blood pressure, the respiratory system, and the urinary system; **(l)(4)(ii)(B)**		
• A 14 inch by 17 inch, or a reasonably standard sized posterior-anterior chest X-ray (after the initial X-ray, the frequency of chest X-rays is to be determined by the examining physician); **(l)(4)(ii)(C)**		
• Pulmonary function tests, including forced vital capacity (FVC) and forced expiratory volume at 1 second (FEV1); **(l)(4)(ii)(D)**		
• Biological monitoring, as required in paragraph (l)(2)(ii)(B) of this section; **(l)(4)(ii)(E)**		
• Blood analysis, in addition to the analysis required under paragraph (l)(2)(ii)(B) of this section, including blood urea nitrogen, complete blood count, and serum creatinine; **(l)(4)(ii)(F)**		
• Urinalysis, in addition to the analysis required under paragraph (l)(2)(ii)(B) of this section, including the determination of albumin, glucose, and total and low molecular weight proteins; **(l)(4)(ii)(G)**		
• For males over 40 years old, prostate palpation, or other at least as effective diagnostic test(s); **(l)(4)(ii)(H)**		
AND		
• Any additional tests deemed appropriate by the examining physician? **(l)(4)(ii)(I)**		
Is periodic biological monitoring provided in accordance with paragraph (l)(2)(ii)(B) of this section? **(l)(4)(iii)**		
If the results of periodic biological monitoring or the results of biological monitoring performed as part of the periodic medical examination show the level of the employee's CdU, β_2-M, or CdB to be in excess of the levels specified in paragraphs (l)(3)(ii) or (iii) or, beginning on January 1, 1999, in excess of the levels specified in paragraphs (l)(3)(ii) or (iv) of this section, does the employer take the appropriate actions specified in paragraphs (l)(3)(ii)-(iv) of this section? **(l)(4)(iv)**		

	YES	NO
For previously exposed employees under paragraph (l)(1)(i)(B) of this section: **(l)(4)(v)**		
If the employee's levels of CdU did not exceed 3 μg/g Cr, CdB did not exceed 5 μg/lwb, and β_2-M did not exceed 300 μg/g Cr in the initial biological monitoring tests, and if the results of the follow up biological monitoring required by paragraph (l)(3)(i)(B) of this section one year after the initial examination confirm the previous results, does the employer discontinue all periodic medical surveillance for that employee? **(l)(4)(v)(A)**		
If the initial biological monitoring results for CdU, CdB, or β_2-M were in excess of the levels specified in paragraph (l)(3)(i) of this section, but subsequent biological monitoring results required by paragraph (l)(3)(ii)-(iv) of this section show that the employee's CdU levels no longer exceed 3 μg/g Cr, CdB levels no longer exceed 5 μg/lwb, and β_2-M levels no longer exceed 300 μg/g Cr, does the employer provide biological monitoring for CdU, CdB, and β_2-M one year after these most recent biological monitoring results? **(l)(4)(v)(B)**		
If the results of the follow up biological monitoring, specified in this paragraph, confirm the previous results, does the employer discontinue all periodic medical surveillance for that employee? **(l)(4)(v)(B)**		
However, if the results of the follow-up tests specified in paragraph (l)(4)(v)(A) or (B) of this section indicate that the level of the employee's CdU, β_2-M, or CdB exceeds these same levels, is the employer required to provide annual medical examinations in accordance with the provisions of paragraph (l)(4)(ii) of this section until the results of biological monitoring are consistently below these levels or the examining physician determines in a written medical opinion that further medical surveillance is not required to protect the employee's health? **(l)(4)(v)(C)**		
Is a routine, biennial medical examination not required to be provided in accordance with paragraphs (l)(3)(i) and (l)(4) of this section if adequate medical records show that the employee has been examined in accordance with the requirements of paragraph (l)(4)(ii) of this section within the past 12 months? **(l)(4)(vi)**		
In that case, are such records maintained by the employer as part of the employee's medical record, and the next routine, periodic medical examination is made available to the employee within two years of the previous examination? **(l)(4)(vi)**		
Actions Triggered by Medical Examinations		
If the results of a medical examination carried out in accordance with this section indicate any laboratory or clinical finding consistent with cadmium toxicity that does not require employer action under paragraph (l)(2), (3) or (4) of this section, does the employer, within 30 days, reassess the employee's occupational exposure to cadmium and take the following corrective action until the physician determines they are no longer necessary: **(l)(5)(i)**		

	YES	NO
• Periodically reassess the employee's work practices and personal hygiene; the employee's respirator use, if any; the employee's smoking history and status; the respiratory protection program; the hygiene facilities; and the maintenance and effectiveness of the relevant engineering controls; **(l)(5)(i)(A)**		
• Within 30 days after the reassessment, take all reasonable steps to correct the deficiencies found in the reassessment that may be responsible for the employee's excess exposure to cadmium; **(l)(5)(i)(B)**		
• Provide semiannual medical reexamination to evaluate the abnormal clinical sign(s) of cadmium toxicity until the results are normal or the employee is medically removed; **(l)(5)(i)(C)**		
AND		
• Where the results of tests for total proteins in urine are abnormal, provide a more detailed medical evaluation of the toxic effects of cadmium on the employee's renal system? **(l)(5)(i)(D)**		
Examination For Respirator Use		
To determine an employee's fitness for respirator use, does the employer provide a medical examination that includes the elements specified in paragraph (l)(6)(i)(A)-(D) of this section?		
Is this examination provided prior to the employee's being assigned to a job that requires the use of a respirator or no later than 90 days after this section goes into effect, whichever date is later, to any employee without a medical examination within the preceding 12 months that satisfies the requirements of this paragraph: **(l)(6)(i)**		
• A detailed medical and work history or update thereof with emphasis on: Past exposure to cadmium; smoking history and current status; any history of renal, cardiovascular, respiratory, hemotopoietic, and/or musculoskeletal system dysfunction; a description of the job for which the respirator is required; and questions 3-11 and 25-32 in appendix D to this section; **(l)(6)(i)(A)**		
• A blood pressure test; **(l)(6)(i)(B)**		
• Biological monitoring of the employee's levels of CdU, CdB and β_2-M in accordance with the requirements of paragraph (l)(2)(ii)(B) of this section, unless such results already have been obtained within the previous 12 months **(l)(6)(i)(C)**		
AND		
• Any other test or procedure that the examining physician deems appropriate? **(l)(6)(i)(D)**		
After reviewing all the information obtained from the medical examination required in paragraph (l)(6)(i) of this section, does the physician determine whether the employee is fit to wear a respirator? **(l)(6)(ii)**		
Whenever an employee has exhibited difficulty in breathing during a respirator fit test or during use of a respirator, does the employer, as soon as possible, provide the employee with a periodic medical examination in accordance with paragraph (l)(4)(ii) of this section to determine the employee's fitness to wear a respirator? **(l)(6)(iii)**		

	YES	NO
Where the results of the examination required under paragraph (l)(6)(i), (ii), or (iii) of this section are abnormal, are medical limitation or prohibition of respirator considered? **(l)(6)(iv)**		
If the employee is allowed to wear a respirator, is the employee's ability to continue to do so periodically evaluated by a physician? **(l)(6)(iv)**		
Emergency Examinations		
In addition to the medical surveillance required in paragraph (l)(2)-(6) of this section, does the employer provide a medical examination as soon as possible to any employee who may have been acutely exposed to cadmium because of an emergency? **(l)(7)(i)**		
Does the examination include the requirements of paragraph (l)(4)(ii) of this section, with emphasis on the respiratory system, other organ systems considered appropriate by the examining physician, and symptoms of acute overexposure, as identified in paragraphs II (B)(1)-(2) and IV of appendix A to this section? **(l)(7)(ii)**		
Termination of Employment Examination		
At termination of employment does the employer provide a medical examination in accordance with paragraph (l)(4)(ii) of this section, including a chest X-ray, to any employee to whom at any prior time the employer was required to provide medical surveillance under paragraphs (l)(1)(i) or (l)(7) of this section? **(l)(8)(i)**		
However, if the last examination satisfied the requirements of paragraph (l)(4)(ii) of this section and was less than six months prior to the date of termination, is no further examination required unless otherwise specified in paragraph (l)(3) or (l)(5) of this section? **(l)(8)(i)**		
However, for employees covered by paragraph (l)(1)(i)(B) of this section, if the employer has discontinued all periodic medical surveillance under paragraph (l)(4)(v) of this section, is no termination of employment medical examination required? **(l)(8)(i)**		
Information Provided to the Physician		
Does the employer provide the following information to the examining physician: **(l)(9)**		
• A copy of this standard and appendices; **(l)(9)(i)**		
• A description of the affected employee's former, current, and anticipated duties as they relate to the employee's occupational exposure to cadmium; **(l)(9)(ii)**		
• The employee's former, current, and anticipated future levels of occupational exposure to cadmium; **(l)(9)(iii)**		
• A description of any personal protective equipment, including respirators, used or to be used by the employee, including when and for how long the employee has used that equipment; **(l)(9)(iv)**		
AND		
• Relevant results of previous biological monitoring and medical examinations? **(l)(9)(v)**		

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	YES	NO
Physician's Written Medical Opinion		
Does the employer promptly obtain a written, signed medical opinion from the examining physician for each medical examination performed on each employee? **(l)(10)(i)**		
Does this written opinion contain: **(l)(10)(i)**		
• The physician's diagnosis for the employee; **(l)(10)(i)(A)**		
• The physician's opinion as to whether the employee has any detected medical condition(s) that would place the employee at increased risk of material impairment to health from further exposure to cadmium, including any indications of potential cadmium toxicity; **(l)(10)(i)(B)**		
• The results of any biological or other testing or related evaluations that directly assess the employee's absorptions of cadmium; **(l)(10)(i)(C)**		
• Any recommended removal from, or limitation on the activities or duties of the employee or the employee's use of personal protective equipment, such as respirators; **(l)(10)(i)(D)**		
AND		
• A statement that the physician has clearly and carefully explained to the employee the results of the medical examination, including all biological monitoring results and any medical condition related to cadmium exposure that require further evaluation or treatment, and any limitation on the employee's diet or use of medications? **(l)(10)(i)(E)**		
Does the employer promptly obtain a copy of the results of any biological monitoring provided by an employer to an employee independently of a medical examination under paragraphs (l)(2) and (l)(4) of this section, and, in lieu of a written medical opinion, an explanation sheet explaining those results? **(l)(10)(ii)**		
Does the employer instruct the physician not to reveal orally or in the written medical opinion given to the employer specific findings or diagnoses unrelated to occupational exposure to cadmium? **(l)(10)(iii)**		
Medical Removal Protection		
General		
Does the employer temporarily remove an employee from work where there is excess exposure to cadmium on each occasion that medical removal is required under paragraph (l)(3), (l)(4) or (l)(6) of this section and on each occasion that a physician determines in a written medical opinion that the employee should be removed from such exposure? **(l)(11)(i)(A)**		
Is the physician's determination based on biological monitoring results, inability to wear a respirator, evidence of illness, other signs or symptoms of cadmium-related dysfunction or disease, or any other reason deemed medically sufficient by the physician? **(l)(11)(i)(A)**		

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	YES	NO
Does the employer medically remove an employee in accordance with paragraph (l)(11) of this section regardless of whether at the time of removal a job is available into which the removed employee may be transferred? **(l)(11)(i)(B)**		
Whenever an employee is medically removed under paragraph (l)(11) of this section, does the employer transfer the removed employee to a job where the exposure to cadmium is within the permissible levels specified in that paragraph as soon as one becomes available? **(l)(11)(i)(C)**		
For any employee who is medically removed under the provisions of paragraph (l)(11)(i) of this section, does the employer provide follow-up biological monitoring in accordance with (l)(2)(ii)(b) of this section, at least every three months and follow-up medical examinations semi-annually at least every six months until in a written medical opinion the examining physician determines that either the employee may be returned to his/her former job status as specified under paragraph (l)(11)(iv)-(v) of this section or remove the employee permanently from excess cadmium exposure? **(l)(11)(i)(D)**		
Does the employer not return an employee who has been medically removed for any reason to his/her former job status until a physician determines in a written medical opinion that continued medical removal is no longer necessary to protect the employee's health? **(l)(11)(i)(E)**		
Where an employee is found unfit to wear a respirator under paragraph (l)(6)(ii) of this section, does the employer remove the employee from work where exposure to cadmium is above the PEL? **(l)(11)(ii)**		
Where removal is based on any reason other than the employee's inability to wear a respirator, does the employer remove the employee from work where exposure to cadmium is at or above the action level? **(l)(11)(iii)**		
Except as specified in paragraph (l)(11)(v) of this section, is no employee who was removed because his/her level of CdU, CdB and/or β_2-M exceeded the medical removal trigger levels in paragraph (l)(3) or (l)(4) of this section returned to work with exposure to cadmium at or above the action level until the employee's levels of CdU fall to or below 3 μg/g Cr, CdB falls to or below 5 μg/lwb, and β_2-M falls to or below 300 μg/g Cr? **(l)(11)(iv)**		
However, when in the examining physician's opinion continued exposure to cadmium will not pose an increased risk to the employee's health and there are special circumstances that make continued medical removal an inappropriate remedy, does the physician fully discuss these matters with the employee, and then in a written determination permit a worker to return his/her former job status despite what would otherwise be unacceptably high biological monitoring results? **(l)(11)(v)**		
Thereafter, does the returned employee continue to be provided with medical surveillance as if he/she were still on medical removal until the employee's levels of CdU fall to or below 3 μg/g Cr, CdB falls to or below 5 μg/lwb, and β_2-M falls to or below 300 μg/g/Cr? **(l)(11)(v)**		

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	YES	NO
Where an employer, although not required by paragraph (l)(11)(i)-(iii) of this section to do so, removes an employee from exposure to cadmium or otherwise places limitations on an employee due to the effects of cadmium exposure on the employee's medical condition, does the employer provide the same medical removal protection benefits to that employee under paragraph (l)(12) of this section as would have been provided had the removal been required under paragraph (l)(11)(i)-(iii) of this section? **(l)(11)(vi)**		
Medical Removal Protection Benefits (MRPB)		
Does the employer provide MRPB for up to a maximum of 18 months to an employee each time and while the employee is temporarily medically removed under paragraph (l)(11) of this section? **(l)(12)(i)**		
For purposes of this section, does the requirement that the employer provide MRPB mean that the employer shall maintain the total normal earnings, seniority, and all other employee rights and benefits of the removed employee, including the employee's right to his/her former job status, as if the employee had not been removed from the employee's job or otherwise medically limited? **(l)(12)(ii)**		
Where, after 18 months on medical removal because of elevated biological monitoring results, the employee's monitoring results have not declined to a low enough level to permit the employee to be returned to his/her former job status: **(l)(12)(iii)**		
Does the employer make available to the employee a medical examination pursuant to this section in order to obtain a final medical determination as to whether the employee may be returned to his/her former job status or must be permanently removed from excess cadmium exposure? **(l)(12)(iii)(A)**		
Does the employer assure that the final medical determination indicates whether the employee may be returned to his/her former job status and what steps, if any, should be taken to protect the employee's health? **(l)(12)(iii)(B)**		
Can the employer condition the provision of MRPB upon the employee's participation in medical surveillance provided in accordance with this section? **(l)(12)(iv)**		
Multiple Physician Review		
If the employer selects the initial physician to conduct any medical examination or consultation provided to an employee under this section, can the employee designate a second physician to: **(l)(13)(i)**		
• Review any findings, determinations, or recommendations of the initial physician; **(l)(13)(i)(A)**		
• Conduct such examinations, consultations, and laboratory tests as the second physician deems necessary to facilitate this review? **(l)(13)(i)(B)**		
Does the employer promptly notify an employee of the right to seek a second medical opinion after each occasion that an initial physician provided by the employer conducts a medical examination or consultation pursuant to this section? **(l)(13)(ii)**		

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YES	NO

Does the employer condition its participation in, and payment for, multiple physician review upon the employee doing the following within fifteen (15) days after receipt of this notice, or receipt of the initial physician's written opinion, whichever is later: **(l)(13)(ii)**

- Informing the employer that he or she intends to seek a medical opinion; **(l)(13)(ii)(A)**
- Initiating steps to make an appointment with a second physician; **(l)(13)(i)(A)**

AND

- If the findings, determinations, or recommendations of the second physician differ from those of the initial physician, then do the employer and the employee assure that efforts are made for the two physicians to resolve any disagreement? **(l)(13)(iii)**

If the two physicians have been unable to quickly resolve their disagreement, then do the employer and the employee, through their respective physicians, designate a third physician to: **(l)(13)(iv)**

- Review any findings, determinations, consultations, laboratory tests, recommendations of the other two physicians; **(l)(13)(iv)(A)**

AND

- Conduct such examinations, consultations, laboratory tests, and discussions with the other two physicians as the third physician deems necessary to revolve the disagreement among them? **(l)(13)(iv)(B)**

Does the employer act consistently with the findings, determinations, and recommendations of the third physician, unless the employer and the employee reach an agreement that is consistent with the recommendations of at least one of the other two physicians? **(l)(13)(v)**

Alternate Physician Determination

Do the employer and an employee or designated employee representative agree upon the use of any alternative form of physician determination in lieu of the multiple physician review provided by paragraph (l)(13) of this section, so long as the alternative is expeditious and at least as protective of the employee? **(l)(14)**

Information the Employer Must Provide the Employee

Does the employer provide a copy of the physician's written medical opinion to the examined employee within two weeks after receipt thereof? **(l)(15)(i)**

Does the employer provide the employee with a copy of the employee's biological monitoring results and an explanation sheet explaining the results within two weeks after receipt thereof? **(l)(15)(ii)**

Within 30 days after a request by an employee, does the employer provide the employee with the information the employer is required to provide the examining physician under paragraph (l)(9) of this section? **(l)(15)(iii)**

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YES	NO

Reporting

In addition to other medical events that are required to be reported on the OSHA Form No. 200, does the employer report any abnormal condition or disorder caused by occupational exposure to cadmium associated with employment as specified in Chapter (V)(E) of the Reporting Guidelines for Occupational Injuries and Illnesses? **(l)(16)**

(m) Communication of Cadmium Hazards to Employees

General

In communications concerning cadmium hazards, do employers comply with the requirements of OSHA's Hazard Communication Standard, 29 CFR 1910.1200, including but not limited to the requirement concerning warning signs and labels, material safety data sheets (MSDS), and employee information and training? **(m)(1)**

In addition, does the employer comply with the following requirements: **(m)(1)**

Warning Signs

Are warning signs provided and displayed in regulated areas? **(m)(2)(i)**

In addition, are warning signs posted at all approaches to regulated areas so that an employee may read the signs and take necessary protective steps before entering the area? **(m)(2)(i)**

Do warning signs required by paragraph (m)(2)(i) of this section bear the following information:

DANGER
CADMIUM
CANCER HAZARD
CAN CAUSE LUNG AND KIDNEY DISEASE
AUTHORIZED PERSONNEL ONLY
RESPIRATORS REQUIRED IN THIS AREA **(m)(2)(ii)**

Does the employer assure that signs required by this paragraph are illuminated, cleaned, and maintained as necessary so that the legend is readily visible? **(m)(2)(iii)**

Warning Labels

Do shipping and storage containers containing cadmium, cadmium compounds, or cadmium contaminated clothing, equipment, waste, scrap, or debris bear appropriate warning levels, as specified in paragraph (m)(3)(ii) of this section? **(m)(3)(i)**

Do the warning labels include at least the following information:

DANGER
CONTAINS CADMIUM
CANCER HAZARD
AVOID CREATING DUST
CAN CAUSE LUNG AND KIDNEY DISEASE **(m)(3)(ii)**

Where feasible, do installed cadmium products have a visible label or other indicaiton that cadmium is present? **(m)(3)(iii)**

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YES	NO

Employee Information and Training

Does the employer institute a training program for all employees who are potentially exposed to cadmium, assure employee participation in the program, and maintain a record of the contents of such program? **(m)(4)(i)**

Is training provided prior to or at the time of initial assignment to a job involving potential exposure to cadmium and at least annually thereafter? **(m)(4)(ii)**

Does the employer make the training program understandable to the employee and assure that each employee is informed of the following: **(m)(4)(iii)**

- The health hazards associated with cadmium exposure, with special attention to the information incorporated in appendix A to the section; **(m)(4)(iii)(A)**
- The quantity, location, manner of use, release, and storage of cadmium in the workplace and the specific nature of operations that could result in exposure to cadmium, especially exposures above the PEL; **(m)(4)(iii)(B)**
- The engineering controls and work practices associated with the employee's job assignment; **(m)(4)(iii)(C)**
- The measure employees can take to protect themselves from exposure to cadmium, including modification of such habits as smoking and personal hygiene, and specific procedures the employer has implemented to protect employees from exposure to cadmium such as appropriate work practices, emergency procedures, and the provision of personal protective equipment; **(m)(4)(iii)(D)**
- The purpose, proper selection, fitting, proper use, and limitations of respirators and protective clothing; **(m)(4)(iii)(E)**
- The purpose and a description of the medical surveillance program required by paragraph (l) of this section; **(m)(4)(iii)(F)**
- The contents of this section and its appendices; **(m)(4)(iii)(G)**

AND

- The employee's rights of access to records under 1910.20(e) and (g)? **(m)(4)(iii)(H)**

Is each employee provided additional access to information and training program and materials? **(m)(4)(iv)**

Does the employer make a copy of this section and its appendices readily available without cost to all affected employees and provide a copy if requested? **(m)(4)(iv)(A)**

Does the employer provide to the Assistant Secretary or the Director, upon request, all materials relating the employee information and the training program? **(m)(4)(iv)(B)**

(n) Record Keeping

Exposure Monitoring

Does the employer establish and keep an accurate record of all air monitoring for cadmium in the workplace? **(n)(1)(i)**

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YES	NO

Does this record include at least the following information: **(n)(1)(ii)**

- The monitoring date, durations, and results in terms of an 8-hour TWA of each sample taken; **(n)(1)(ii)(A)**
- The name, social security number, and job classifications of the employees monitored and of all other employees whose exposures the monitoring is intended to represent; **(n)(1)(ii)(B)**
- A description of the sampling and analytical methods used and evidence of their accuracy; **(n)(1)(ii)(C)**
- The type of respiratory protective device, if any, worn by the monitored employee; **(n)(1)(ii)(D)**

AND

- A notation of any other conditions that might have affected the monitoring results? **(n)(1)(ii)(E)**

Does the employer maintain this record for at least thirty (30) years, in accordance with 29 CFR 1910.20? **(n)(1)(iii)**

Objective Data For Exemption From Requirement For Initial Monitoring

Note: For the purposes of this section, object data are information demonstrating that a particular product or material containing cadmium or a specific process, operation, or activity involving cadmium cannot release dust or fumes in concentrations at or above the action level even under the worst-case release conditions. Objective data can be obtained from an industry-wide study or from laboratory product test results from manufacturers of cadmium-containing products or materials. The data the employer uses from an industry-wide survey must be obtained under workplace conditions closely resembling the processes, types of material, control methods, work practices and environmental conditions in the employer's current operations. **(n)(2)(i)**

Does the employer establish and maintain a record of the objective data for at least 30 years? **(n)(2)(ii)**

Medical Surveillance

Does the employer establish and maintain an accurate record for each employee covered by medical surveillance under paragraph (l)(1)(i) of this section? **(n)(3)(i)**

Does the record include at least the following information about the employee: **(n)(3)(ii)**

- Name, social security number, and description of the duties; **(n)(3)(ii)(A)**
- A copy of the physician's written opinions and an explanation sheet for biological monitoring results; **(n)(3)(ii)(B)**
- A copy of the medical history, and the results of any physical examination and all test results that are require to be provided by this section, including biological tests, etc., or that have been obtained to further evaluate any condition that might be related to cadmium exposure; **(n)(3)(ii)(C)**
- The employee's medical symptoms that might be related to exposure to cadmium; **(n)(3)(ii)(D)**

	YES	NO
AND		
• A copy of the information provided to the physician as required by paragraph (l)(9)(ii)-(v) of this section? **(n)(3)(ii)(E)**		
Does the employer assure that this record is maintained for the duration of employment plus thirty (30) years, in accordance with 29 CFR 1910.20? **(n)(3)(iii)**		
Training		
Does the employer certify that employees have been trained by preparing a certification record which includes the identity of the person trained, signature of the employer or the person who conducted the training, and the date the training was completed? **(n)(4)**		
Are the certification records prepared at the completion of training and maintained on file for one (1) year beyond the date of training of the employee? **(n)(4)**		
Availability		
Except as otherwise provided for in this section, is access to all records required to be maintained by paragraphs (n)(1)-(4) of this section in accordance with the provisions of 29 CFR 1910.20? **(n)(5)(i)**		
Within 15 days after a request, does the employer make an employee's medical records required to be kept by paragraph (n)(3) of this section available for examination and copying to the subject employee, to designated representatives, to anyone having the specific written consent of the subject employee, and after the employee's death or incapacitation, to the employee's family members? **(n)(5)(ii)**		
Transfer of Records		
Whenever an employer ceases to do business and there is no successor employer to receive and retain records for the prescribed period or the employer intends to dispose of any records required to be preserved for at least 30 years, does the employer comply with the requirements concerning transfer of records set forth in 29 CFR 1910.20(h)? **(n)(6)**		
(o) Observation of Monitoring		
Employee Observation		
Does the employer provide affected employees or their designated representatives an opportunity to observe any monitoring of employee exposure to cadmium? **(o)(1)**		
When observation of monitoring requires entry into an area where the use of protective clothing or equipment is required, does the employer provide the observer with that clothing and equipment and assure that the observer uses such clothing and equipment and complies with all other applicable safety and health procedures? **(o)(2)**		
(p) Dates		
Effective Date		
This section shall become effective December 14, 1992. **(p)(1)**		

	YES	NO
Start-up Date		
All obligations of this section commence on the effective date except as follows: **(p)(2)**		
Exposure Monitoring		
Except for small businesses (nineteen (19) or fewer employees), is initial monitoring required by paragraph (d) (2) of this section completed as soon as possible and in any event no later than 60 days after the effective date of this standard? **(p)(2)(i)**		
For small businesses, is initial monitoring required by paragraph (d)(2) of this section completed as soon as possible and in any event no later than 120 days after the effective date of this standard? **(p)(2)(i)**		
Regulated Areas		
Except for small businesses, defined under paragraph (p)(2)(i) of this section are regulated areas required to be established by paragraph (e) of this section set up as soon as possible after the results of exposure monitoring are known and in any event no later than 90 days after the effective date of this section? **(p)(2)(ii)**		
For small businesses, are regulated areas required to be established by paragraph (e) of this section set up as soon as possible after the results of exposure monitoring are known and in any event no later than 150 days after the effective date of this section? **(p)(2)(ii)**		
Respiratory Protection		
Except for small businesses, defined under paragraph (p)(2)(i) of this section, is respiratory protection required by paragraph (g) of this section provided as soon as possible and in any event no later than 90 days after the effective date of this section? **(p)(2)(iii)**		
For small businesses, is respiratory protection required by paragraph (g) of this section provided as soon as possible and in any event no later than 150 days after the effective date of this section? **(p)(2)(iii)**		
Compliance Program		
Are written compliance programs required by paragraph (F)(2) of this section completed and available for inspection and copying as soon as possible and in any event no later than 1 year after the effective date of this section? **(p)(2)(iv)**		
Methods of Compliance		
Are the engineering controls required by paragraph (f)(1) of this section implemented as soon as possible and in any event no later than two (2) years after the effective date of this section? **(p)(2)(v)**		
Are work practice controls implemented as soon as possible? **(p)(2)(v)**		
Are work practice controls that are directly related to engineering controls to be implemented in accordance with the compliance plan implemented as soon as possible after such engineering controls are implemented? **(p)(2)(v)**		

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Hygiene and Lunchroom Facilities

Are hand washing facilities, permanent or temporary, provided in accordance with 29 CFR 1910.141 (d)(1) and (2) as soon as possible and in any event no later than 60 days after the effective date of this section? **(p)(2)(vi)(A)**

Are change rooms, showers, and lunchroom facilities completed as soon as possible and in any event no later than 1 year after the effective date of this section? **(p)(2)(vi)(B)**

Employee Information and Training

Except for small businesses, defined under paragraph (p)(2)(i) of this section, is employee information and training required by paragraph (m)(4) of this section provided as soon as possible and in any event no later than 90 days after the effective date of this standard? **(p)(2)(vii)**

For small business, is employee information and training required by paragraph (m)(4) of this standard provided as soon as possible and in any event no later than 180 days after the effective date of this standard? **(p)(2)(vii)**

Medical Surveillance

Except for small businesses, defined under paragraph (p)(2)(i) of this section, are initial medical examinations required by paragraph (1) of this section provided as soon as possible and in any event no later than 90 days after the effective date of this standard? **(p)(2)(viii)**

For small business, are initial medical examinations required by paragraph (1) of this section provided as soon as possible and in any event no later than 180 days after the effective date of this standard? **(p)(2)(viii)**

(q) Appendices

Appendix C to this section is incorporated as part of this section, and compliance with its contents is mandatory. **(q)(1)**

Except where portions of appendices A, B, D, E, and F to this section are expressly incorporated in requirements of this section, these appendices are purely informational and are not intended to create any additional obligations not otherwise imposed or to detract form any existing obligations.

YES	NO

(Next page is Z-19)

YES	NO

1910.1028 BENZENE

	YES	NO
Scope and Application (a)		
This standard applies to all occupational exposures to benzene, except as follows: (a)(1)		
Storage, transportation, distribution, dispensing, sale, or use of gasoline, motor fuels, or other fuels containing benzene subsequent to its final discharge from bulk wholesale storage facilities is exempt, except where the gasoline or motor fuels are dispensed in an indoor location for more than four hours per day. (a)(2)(i)		
Loading/unloading operations at bulk wholesale storage facilities which use vapor control systems for all operations are exempt from this standard, except for the provision the hazard communication standard which apply and the emergency provisions of this standard (see sections g and i.4) (a)(2)(ii)		
Storage, transportation, distribution, or sale of benzene or liquid mixtures containing more than 0.1% benzene in intact containers, or in transportation pipelines while sealed in such a manner as to contain benzene vapors or liquid, except for the provision the hazard communication standard which apply and the emergency provisions of this standard (see sections g and i.4). (a)(2)(iii)		
Containers and pipelines carrying mixtures with less than 0.1% benzene and natural gas processing plants processing gas with less than 0.1% benzene are also exempt from the standard. (a)(2)(iv)		
Until September 12, 1988: Work operations where the only exposure to benzene is from liquid mixtures containing 0.5% benzene or less by volume, or the vapors released from such liquids are exempt from this standard. (a)(2)(v)		
From September 12, 1988 to September 12, 1989 Work operations where the only exposure to benzene is from liquid mixtures containing 0.3% or less of benzene by volume, or the vapors released from such liquids are exempt from this standard. (a)(2)(v)		
After September 12, 1989 Work operations where the only exposure to benzene is from liquid mixtures containing 0.1% or less of benzene by volume, or the vapors released from such liquids, are exempt from this standard, [except that tire building machine operators using solvents with more than 0.1% benzene are covered by section (i)]. (a)(2)(v)		
Oil and gas drilling, production, and servicing operations are exempt from this standard. (a)(2)(vi)		
Coke oven batteries are exempt from this standard. (a)(2)(vii)		
Cleaning and repair of barges and tankers which have contained benzene are excluded from paragraphs (f), (e.1), and (e.6). Engineering and work practice controls must be used to keep exposures below 10 ppm unless it is proven to be not feasible. (a)(3)		
Definitions (b)		
Permissible Exposure Limits (c)		
Is employee exposure to airborne concentrations of benzene limited to no more than one part of benzene per million parts of air (1 ppm) as an 8-hour time weighted average (TWA)? (c)(1)		
Are precautions taken to ensure that no employee is exposed to an airborne concentration of benzene in excess of 5 ppm as averaged over any 15 minute period (the STEL or short term exposure limit)? (c)(2)		

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	YES	NO
Regulated Areas (d)		
Are regulated areas established wherever the airborne concentration of benzene exceeds or can reasonably be expected to exceed the permissible exposure limits (TWA or STEL) above? (d)(1)		
Is access to regulated areas limited to authorized persons? (d)(2)		
Are regulated areas set up so as to minimize the number of employees exposed to benzene in the regulated area? (d)(3)		
Exposure Monitoring (e)		
Is employee exposure monitoring conducted by taking breathing zone air samples representative of each employee's average exposure to airborne benzene? (e)(1)(i)		
Are representative 8-hour TWA employee exposures determined on the basis of one sample or samples representing the full shift exposure for each job classification in each work area? (e)(1)(ii)		
Are determinations of compliance with the short term exposure limit made from 15-minute employee breathing zone samples measured at operations where there is reason to believe exposures are high; such as where tanks are opened, filled, unloaded, or gauged; where containers or process equipment are opened and where benzene is used for cleaning or as a solvent in an uncontrolled situation? (Objective data such as measurements from brief period measuring devices may be used to determine where STEL monitoring is needed.) (e)(1)(iii)		
Where one shift will consistently have higher exposures for an operation, representative employee exposures for that operation may be determined during the shift on which the highest exposure is expected (except for initial monitoring). (e)(1)(iv)		
Is each workplace and work operation monitored to determine the airborne concentrations of benzene to which employees may be exposed? (e)(2)(i)		
Has initial monitoring been completed within 60 days of the effective date of this standard or within 30 days of the introduction of benzene into the workplace? (e)(2)(ii)		
Results of monitoring conducted within one year prior to the effective date of the standard which satisfies all other requirements of this section may be used as initial monitoring results. (e)(2)(ii)		
If initial monitoring reveals employee exposure at or above the action level but at or below the time weighted average (1 ppm), is monitoring repeated for each such employee at least every year? (e)(3)(i)		
If the monitoring reveals employee exposure above the TWA (1 ppm), is monitoring repeated for each such employee at least every six months? (e)(3)(ii)		
If two consecutive measurements taken at least seven days apart indicate the exposure has decreased to the TWA or below, but still above the action level, the employer may alter the monitoring schedule from every six months to annually. (e)(3)(iii)		
Is monitoring for the STEL repeated as necessary to evaluate the exposures of employees subject to short term exposures? (e)(3)(iv)		
If initial monitoring reveals employee exposure below the action level, initial monitoring may be discontinued except as in (e.5) below. (e)(4)(i)		

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	YES	NO
If periodic monitoring reveals employee exposure below the action level, periodic monitoring may be discontinued except as in (e.5) below. **(e)(4)(i)**		
Is exposure monitoring reinstituted whenever there is a change in the production, process, control equipment, personnel, or work practices which might result in new or additional exposures to benzene? **(e)(5)(i)**		
When spills, leaks, ruptures, or other breakdowns occur that may lead to employee exposure, is area or personal sampling used to monitor after the cleanup to ensure that exposures have returned to the level that existed prior to the incident? **(e)(5)(ii)**		
Is monitoring accurate to a confidence level of 95% to within plus or minus 25% for airborne concentrations of benzene? **(e)(6)**		
Are employees notified of monitoring results within 15 working days after the receipt of results in writing or by posting in an appropriate and accessible location? **(e)(7)(i)**		
When the permissible exposure limits are exceeded, does the written notification indicate the corrective action being taken to reduce employee exposures to or below the PEL, or refer to a document which contains this information? **(e)(7)(ii)**		
Methods of Compliance **(f)**		
Are engineering controls and work practices instituted to reduce benzene exposures to or below the permissible exposure limits, except to the extent that the controls can be established to be infeasible or where the provisions of paragraphs (f.1.iii) or (g.1) apply? **(f)(1)(i)**		
Where feasible engineering and work practice controls are not sufficient to reduce employee exposures to or below the permissible exposure limits, are they used to reduce employee exposure to the lowest levels achievable and are these controls supplemented by the use of respiratory protection used in compliance with paragraph (g)? **(f)(1)(ii)**		
If benzene is used in a workplace less than a total of 30 days per year, the employer may use engineering controls, work practice controls, or respiratory protection, or any combination, to reduce benzene exposure to or below the PELs, except that engineering and work practices controls must be used, if feasible, to reduce exposure to or below 10 ppm as an 8-hour TWA. **(f)(1)(iii)**		
Is a written compliance program established when any exposures are above the PEL, outlining the engineering and work practice controls to be used as primary means to reduce exposures below the PEL? **(f)(2)(i)**		
Does the written program include a schedule for implementation of the work practice and engineering controls? **(f)(2)(ii)**		
Are these plans reviewed and revised as appropriate based on the most recent exposure monitoring data to reflect the current status of the program? **(f)(2)(ii)**		
Are written compliance programs available for examination and copying to affected employees, designated employee representatives, and OSHA and NIOSH officials? **(f)(2)(iii)**		
Respiratory Protection **(g)**		
Are respirators provided and used where required? **(g)(1)**		
Are respirators used under the following circumstances:		
During the time necessary to install or implement feasible engineering and work practice controls? **(g)(1)(i)**		

1910.1028 BENZENE

	YES	NO
In work operations where compliance with the TWA or STEL through engineering or work practice controls is not feasible (such as maintenance/repair activities, vessel cleaning, etc.)? **(g)(1)(ii)**		
In work situations where feasible engineering and work practice controls are insufficient to reduce exposure to or below the PEL? **(g)(1)(iii)**		
In work situations described in (f.1.iii) above, where benzene exposure is a hazard fewer than 30 days per year? **(g)(1)(iii)**		
In emergencies? **(g)(1)(iv)**		
Where respirators are required, are they provided at no cost to the employee and appropriate to the hazards as specified in Table 1? **(g)(2)(i)**		
Is the requirement for use of respirators enforced? **(g)(2)(i)**		
Are the respirators selected NIOSH- and MSHA-approved? **(g)(2)(ii)**		
Are filter elements for negative pressure respirators approved by MSHA/NIOSH for organic vapors or benzene? **(g)(2)(ii)**		
Are employees who cannot wear a negative pressure respirator given the option of wearing a respirator with less breathing resistance such as a powered air-purifying respirator or supplied air respirator? **(g)(2)(iii)**		
Has a respiratory protection program in accordance with Subpart I, 1910.134 (b), (d), (e), and (f) been instituted? **(g)(3)**		
Where air purifying respirators are used, are air-purifying elements replaced at the expiration of service life or at the beginning of each shift in which they will be used, whichever comes first? **(g)(4)(i)**		
If an air-purifying element becomes available that has an approved end of useful life indicator for benzene, the element may be used until the indicator shows no further useful life. **(g)(4)(ii)**		
Are employees who wear respirators allowed to leave the regulated area to wash their faces and respirator facepieces as necessary to prevent skin irritation or to change the filter elements whenever they detect a change in breathing resistance or chemical vapor breakthrough? **(g)(4)(iii)**		
Are quantitative or qualitative respirator fit tests performed at the time of initial fitting and at least annually thereafter for each employee wearing negative pressure respirators? **(g)(5)(i)**		
Is the fit test used to select a respirator facepiece which exhibits minimum leakage and provides the required protection as outlined in Table 1? **(g)(5)(i)**		
Is a respirator that the fit test shows provides the required protection provided to the employees, are employees required to wear such respirators, and is this requirement enforced? **(g)(5)(i)**		
Are the protocols outlined in Appendix E followed for respirator fit testing procedures? **(g)(5)(ii)**		
Protective Clothing and Equipment **(h)**		
Is personal protective equipment provided and worn where there is danger of eye contact with or dermal exposure to liquid benzene? **(h)**		
Is personal protective equipment provided at no cost to the employee and is the use of ppe assured where necessary? **(h)**		

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	YES	NO
Does eye and face protection meet the requirements of Subpart I, 1910.133? (h)		
Medical Surveillance (i)		
Is a medical surveillance program made available for:		
employees who are or may be exposed to benzene at or above the action level 30 or more days per year;		
for employees who are or may be exposed to benzene at or above the permissible exposure limits for 10 or more days per year;		
for employees who have been exposed to more than 10 ppm of benzene for 30 or more days in a year prior to the standard's effective date when employed by their current employer; and		
for tire building machine operators in tire building operations, who use solvents containing greater than 0.1% benzene? (i)(1)(i)		
Are medical examinations and procedures performed by or under the supervision of a licensed physician? (i)(1)(ii)		
Are all laboratory tests conducted by an accredited laboratory? (i)(1)(ii)		
Have persons other than licensed physicians who administer the pulmonary function testing completed a training course in spirometry sponsored by an appropriate governmental, academic, or professional institution? (i)(1)(iii)		
Are all examinations and procedures provided without cost to the employee and at a reasonable time and place? (i)(1)(iv)		
Within 60 days of the effective date of this standard, or before the time of initial assignment, are employees given a medical examination including the following elements: (i)(2)(i)		
A detailed occupational history including:		
Past work exposure to benzene or any other hematological toxins;		
A family history of blood dyscrasias including hematological neoplasms;		
A history of blood dyscrasias including genetic hemoglobin abnormalities, bleeding abnormalities, abnormal function of formed blood elements;		
A history of renal or liver dysfunction;		
A history of previous exposure to ionizing radiation; and		
Exposure to marrow toxins outside of the current work situation (i)(2)(i)(A)		
A complete physical examination (i)(2)(i)(B)		
A complete blood count including a leukocyte count with differential, a quantitative thrombocyte count, hematocrit, hemoglobin, erythrocyte count and erythrocyte indices (MCV, MCH, MCHC). (i)(2)(i)(C)		
Are the results of the above tests reviewed by the examining physician? (i)(2)(i)(C)		
Additional tests as necessary in the opinion of the examining physician, based on alterations to the components of the blood or other signs which may be related to benzene exposure; and (i)(2)(i)(D)		
For all workers required to wear respirators for at least 30 days a year, the physical examination shall pay special attention to the cardiopulmonary system and shall include a pulmonary function test. (i)(2)(i)(E)		

1910.1028 BENZENE

	YES	NO
No initial medical examination is required if adequate records show that the employee has been examined in accordance with the above requirements within the 12 months prior to the effective date of this standard. (i)(2)(ii)		
Are employees covered under paragraph (i.1.i) provided with an annual medical examination which includes the following elements: (i)(3)(i)		
A brief history of new exposure to potential marrow toxins, changes in medicinal drug use, and the appearance of physical signs relating to blood disorders; (i)(3)(i)(A)		
A complete blood count including a leukocyte count with differential quantitative thrombocyte count, hemoglobin, hematocrit, erythrocyte count and erythrocyte indices (MCV, MCH, CHC); and (i)(3)(i)(B)		
Appropriate additional tests as necessary, in the opinion of the examining physician, in consequence of alterations in the components of the blood or other signs which may be related to benzene exposures. (i)(3)(i)(C)		
When an employee develops signs and symptoms commonly associated with toxic exposure to benzene, is the employee provided with an additional medical examination which includes those elements considered appropriate by the examining physician? (i)(3)(ii)		
Is a pulmonary function test performed every three years for those persons required to use respirators for at least 30 days a year? (i)(3)(iii)		
At the time of the pulmonary function test is a specific evaluation of the cardiopulmonary system made? (i)(3)(iii)		
In addition to the surveillance required above, if an employee is exposed to benzene in an emergency situation, is the employee given a urine sample at the end of the shift and a urinary phenol test performed on the sample within 72 hours (and the urine specific gravity corrected to 1.024)? (i)(4)(i)		
If the result of the urinary phenol test is below 75 mg phenol/L or urine, no further testing is required. (i)(4)(ii)		
If the result of the urinary phenol test is equal to or greater than 75 mg phenol/L of urine, is the employee provided with a complete blood count including an erythrocyte count, leukocyte count with differential and thrombocyte count at monthly intervals for a duration of three months following the emergency exposure? (i)(4)(iii)		
If any conditions specified in the next paragraph (i.5.i) exist, are the further requirements of paragraph (i.5) met and are employees provided with periodic examinations if directed by the physician? (i)(4)(iv)		
Where the results of the complete blood count required for the initial and periodic examinations indicate any of the following abnormal conditions exist, is the blood count repeated within two weeks? (i)(5)(i)		
The hemoglobin level or hematocrit falls below the normal limit (outside the 95% confidence interval) as determined by the laboratory for the particular geographic area and/or these indices show a persistent downward trend from the individual's pre-exposure norms; provided these findings cannot be explained by other medical reasons. (i)(5)(i)(A)		
The thrombocyte (platelet) count varies more than 20% below the employee's most recent values or falls outside the normal limit (95% confidence interval) as determined by the laboratory. (i)(5)(i)(B)		

1910.1028 BENZENE

	YES	NO
The leukocyte count is below 4,000 per mm^3 or there is an abnormal differential count. **(i)(5)(i)(C)**		
If the abnormality persists, does the examining physician refer the employee to a hematologist or an internist for further evaluation unless the physician has good reason to believe such referral is unnecessary (see Appendix C for examples of conditions where a referral may be unnecessary)? **(i)(5)(ii)**		
Is the hematologist or internist provided with the information required under paragraph (i.6) and the medical record required by paragraph (k.2.ii)? **(i)(5)(iii)**		
Does the hematologist's or internist's evaluation include a determination as to the need for additional tests, and does the employer assure that these tests are provided? **(i)(5)(iv)**		
Is the following information provided to the examining physician:		
A copy of this regulation and its appendices; **(i)(6)(i)**		
A description of the affected employee's duties as they relate to the employee's exposure; **(i)(6)(ii)**		
The employee's actual or representative exposure level; **(i)(6)(iii)**		
A description of any personal protective equipment used or to be used; and **(i)(6)(iv)**		
Information from previous employment-related medical examinations of the affected employee which is not otherwise available to the examining physician. **(i)(6)(v)**		
For each examination under this section, is the employee provided with a copy of the examining physician's written opinion within 15 days of the examination? **(i)(7)(i)**		
Is the written opinion limited to the following information: **(i)(7)(i)**		
The occupationally pertinent results of the medical examination and tests; **(i)(7)(i)(A)**		
The physician's opinion concerning whether the employee has any detected medical conditions which would place the employee's health at greater than normal risk of material impairment from exposure to benzene; **(i)(7)(i)(B)**		
The physician's recommended limitations upon the employee's exposure to benzene or upon the employee's use of protective clothing or equipment and respirators; **(i)(7)(i)(C)**		
A statement that the employee has been informed by the physician of the results of the medical examination and any medical conditions resulting from benzene exposure which require further explanation or treatment. **(i)(7)(i)(D)**		
Does the written opinion not reveal specific records, findings, and diagnoses which have no bearing on the employee's ability to work in a benzene-exposed workplace? **(i)(7)(ii)**		
When a physician makes a referral to a hematologist/internist as required in (i.5.i) above, is the employee removed from areas where exposures may exceed the action level until the physician makes a determination under (i.8.ii) of this section? **(i)(8)(i)**		
Is a decision made by the physician in consultation with the hematologist/internist following the examination and evaluation on whether to remove the employee from areas where benzene exposure is above the action level or allow that employee to return to areas where benzene exposure is above the action level? **(i)(8)(ii)**		

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	YES	NO
Is this decision communicated in writing to the employers and employee. In the case of removal, is the required probable duration of removal from occupational exposure to benzene above the action level outlined and the requirements for future medical examinations to review the decision discussed? **(i)(8)(ii)**		
For any employee who is removed from exposure, is a follow-up examination provided? **(i)(8)(iii)**		
Within six months of the employee's removal, is a decision by the physician in consultation with the hematologist/internist made as to whether the employee may be returned to the usual job or whether the removal should be permanent? **(i)(8)(iii)**		
Whenever an employee is temporarily removed from benzene exposure is the employee transferred to a comparable job for which the employee is qualified or can be trained for in a short period, and where benzene exposures are as low as possible, but in no event higher than the action level? **(i)(8)(iv)**		
Are the employee's current wage rate, seniority, and other benefits maintained? **(i)(8)(iv)**		
If no such job is available, are medical removal protection benefits provided until such a job becomes available or for six months, whichever comes first? **(i)(8)(iv)**		
When an employee is removed permanently from benzene exposure based on a physician's recommendation, is the employee given an opportunity to transfer to another position which becomes available for which the employee is qualified or can be trained for in a short period, and where benzene exposures are as low as possible, but in no event higher than the action level? **(i)(8)(v)**		
Does the employer suffer no reduction in current wage rate, seniority or other benefits as a result of the transfer? **(i)(8)(v)**		
When an employee is removed from benzene exposure because of hematological findings, unless the employee is transferred to a comparable job where benzene exposures are below the action level, are six months of medical removal protection benefits provided? **(i)(9)(i)**		
Providing medical removal protection benefits means the employer maintains the current wage rate, seniority, and other benefits of an employee as though the employee had not been removed. **(i)(9)(ii)**		
The obligation to provide medical removal protection benefits to a removed employee are reduced to the extent that the employee receives compensation for earnings lost during the removal period either from a publicly or employer-funded compensation program, or from employment with another employer made possible by the removal. **(i)(9)(iii)**		
Communication of Benzene Hazards to Employees **(j)**		
Are signs posted at entrances to regulated areas that read:		
DANGER BENZENE CANCER HAZARD FLAMMABLE — NO SMOKING AUTHORIZED PERSONNEL ONLY RESPIRATOR REQUIRED **(j)(1)(i)**		
Are labels or other appropriate forms of warning provided for containers of benzene within the workplace? (Pipes are not required to be labeled.) **(j)(1)(ii)**		

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1910.1028 BENZENE

	YES	NO
Do the labels comply with the requirements of 29 CFR 1910.1200(f) (hazard communication standard) and include the following legend: DANGER CONTAINS BENZENE CANCER HAZARD **(j)(1)(ii)**		
Has a material safety data sheet (MSDS) for benzene been obtained and developed and do employees have access to the MSDS? Does the MSDS comply with 29 CFR 1910.1200? **(j)(2)(i)**		
Employers who are manufacturers or importers must:		
Comply with paragraph (a) of this section; and		
Comply with the requirement in 29 CFR 1910.1200 (the hazard communication standard) that they deliver to downstream employers an MSDS which addresses benzene. **(j)(2)(ii)**		
Are employees provided with information and training at the time of their initial assignment to a work area where benzene is present? **(j)(3)(i)**		
If exposures are above the action level, is information and training provided at least annually thereafter? **(j)(3)(i)**		
Is the training program in accordance with the requirements of 29 CFR 1910.1200 (h.1 and h.2) and does it include specific information on benzene for each category of information included in that section? **(j)(3)(ii)**		
In addition to the information required under 29 CFR 1910.1200, is the following accomplished:		
Provide employees with an explanation of the contents of this section, including Appendices A and B, and indicate to them where the standard is available; and **(j)(3)(iii)(A)**		
Describe the medical surveillance program required under paragraph (i) of this section, and explain the information contained in Appendix C. **(j)(3)(iii)(B)**		
Recordkeeping **(k)**		
Is an accurate record of all measurements required by paragraph (e) kept, in accordance with 29 CFR 1910.20? **(k)(1)(i)**		
Does this record include:		
The dates, number, duration, and results of each of the samples taken, including a description of the procedure used to determine representative employee exposures. **(k)(1)(ii)(A)**		
A description of the sampling and analytical methods used; **(k)(1)(ii)(B)**		
A description of the type of respiratory protective devices worn, if any; and **(k)(1)(ii)(C)**		
The name, social security number, job classification, and exposure levels of the employee monitored and all other employees whose exposure the measurement is intended to represent. **(k)(1)(ii)(D)**		
Is this record maintained for at least 30 years, in accordance with 29 CFR 1910.20? **(k)(1)(iii)**		
Is an accurate record for each employee subject to medical surveillance established and maintained in accordance with the requirements of 29 CFR 1910.20? **(k)(2)(i)**		

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	YES	NO
Does this record include:		
The name and social security number of the employee; **(k)(2)(ii)(A)**		
The employer's copy of the physician's written opinion on the initial, periodic, and special examinations and all tests, opinions, and recommendations; **(k)(2)(ii)(B)**		
Any employee medical complaints related to exposure to benzene; **(k)(2)(ii)(C)**		
A copy of the information provided to the physician as required by paragraphs (i.6.ii) through (i.6.v) of this section; and **(k)(2)(ii)(D)**		
A copy of the employee's medical and work history related to exposure to benzene or any other hematologic toxins. **(k)(2)(ii)(E)**		
Are these records maintained for at least the duration of employment plus 30 years in accordance with 29 CFR 1910.20? **(k)(2)(iii)**		
Are all records required to be maintained by this section made available upon request for examination and copying to the Assistant Secretary of Labor and the Director of NIOSH? **(k)(3)(i)**		
Are employee exposure monitoring records required by this paragraph provided upon request for examination and copying to employees, employee representatives, and the Assistant Secretary of Labor, in accordance with 29 CFR 1910.20(a-e and g-i)? **(k)(3)(ii)**		
Are employee medical records required by this paragraph provided upon request for examination and copying to the subject employee or anyone having the specific written consent of the subject employee, and to the Assistant Secretary of Labor in accordance with 29 CFR 1910.20? **(k)(3)(iii)**		
Are the requirements of 29 CFR 1910.20(h) involving transfer of records complied with? **(k)(4)(i)**		
If the employer ceases to do business and there is no successor employer to receive and retain the records for the prescribed period, the employer must notify the Director of NIOSH at least three months prior to disposal, and transmit them to the Director if so asked. **(k)(4)(ii)**		
Observation of Monitoring **(l)**		
Are affected employees or their designated representatives given an opportunity to observe the measuring or monitoring of employee exposure to benzene conducted under paragraph (e) of this section? **(l)(1)**		
When observation of the measuring or monitoring of employee exposure to benzene requires entry into areas where protective clothing and equipment or respirators is required, are observers provided with the same equipment used by employees working in the area, is the use of such clothing and equipment assured, and are the observers required to comply with all other applicable safety and health procedures? **(l)(2)**		
Dates **(m)**		
The standard becomes effective December 10, 1987 **(m)(1)**		

1910.1028 BENZENE

	YES	NO
The requirements of paragraphs (a) through (m) of this section, except the engineering control requirements of (f.1) must be completed within 60 days after the effective date of this standard. **(m)(2)(i)**		
The engineering and work practice controls of paragraph (f.1) must be implemented no later than two years after the effective date of this standard. **(m)(2)(ii)**		
Coke and coal chemical operations may comply with paragraph (m.2.ii) of this section or alternately include within the compliance program required by paragraph (f.2) of this section, a requirement to phase in engineering controls as equipment is repaired and replaced. **(m)(2)(iii)**		

1910.1028 BENZENE

	YES	NO
For coke and coal chemical operations choosing the latter alternative, compliance with the engineering controls requirements of (f.1) must be achieved no later than five years after the effective date of this standard and substantial compliance with the engineering control requirements must be achieved within three years of the effective date of this standard. **(m)(2)(iii)**		

Q1

1910.1029 – COKE OVEN EMISSIONS

YES | NO

(a) Scope

This section became effective January 20,1977 and applies to the control of employee exposure to coke oven emissions. Excepted are working conditions over which other Federal agencies exercise statutory authority. (a)

(b) Definitions

Authorized person – any person specifically authorized by the employer whose duties require the person to enter a regulated area, or any person entering such an area as a designated representative of employees for the purpose of exercising the opportunity to observe monitoring and measuring procedures under paragraph (n) of this section.

Beehive oven – a coke oven in which the products of carbonization other than coke are not recovered, but are released into the ambient air.

Coke oven – a retort in which coke is produced by the destructive distillation of carbonization of coal.

Coke oven battery – a structure containing a number of slot-type coke ovens.

Director – the Director, National Institute for Occupational Safety and Health, U.S. Department of Health, Education, and Welfare, or his or her designee.

Emergency – any occurrence such as, but not limited to, equipment failure which is likely to, or does, result in any massive release of coke oven emissions.

Existing coke oven battery – a battery in operation or under construction on January 20, 1977, and which is not a rehabilitated coke oven battery.

Rehabilitated coke oven battery – a battery which is rebuilt, overhauled, renovated, or restored such as from the pad up, after January 20, 1977.

Secretary – the Secretary of Labor, U.S. Department of Labor, or his or her designee.

Stage charging – a procedure by which a predetermined volume of coal in each larry car hopper is introduced into an oven such that no more than two hoppers are discharging simultaneously.

Sequential charging – means a procedure, usually automatically timed, by which a predetermined volume of coal in each larry car hopper is introduced into an oven such that no more than two hoppers commence or finish discharging simultaneously although, at some point, all hoppers are discharging simultaneously.

Pipeline charging – any apparatus used to introduce coal into an oven which uses a pipe or duct permanently mounted onto an oven and through which coal is charged.

Green push – coke which when removed from the oven results in emissions due to the presence of unvolatilized coal. (b)

(c) Permissible Exposure Limits

Is employee exposure to coke oven emissions, in the regulated area, limited to concentrations of not more than 150 micrograms per cubic meter of air (150 $\mu g/m^3$) for an 8-hour day? (c)

1910.1029 – COKE OVEN EMISSIONS

YES | NO

(d) Regulated Areas (d)

Have regulated areas been established and access limited to authorized persons? (d)(1)

Have the following been made regulated areas? (d)(2)

The coke oven battery including topside and its machinery, pushside and its machinery, coke side and its machinery, and the battery ends; the wharf; and the screening station? (d)(2)(i)

The beehive oven and its machinery? (d)(2)(ii)

(e) Exposure Monitoring and Measurement (e)

Monitoring Programs.

Are employees who work in the regulated area monitored to measure their exposure to coke oven emissions? (e)(1)(i)

Are the measurements representative of each employee's exposure to coke oven emissions over an eight-hour period, without regard to the use of respirator protection? (e)(1)(ii)

Are full shift (minimum 7 continuous hours) personal samples collected, including at least one sample during each shift for each battery and each classification within the regulated areas including at least the following job classifications? (e)(1)(iii)

(a) Lidman;
(b) Tar chaser;
(c) Larry car operator;
(d) Luterman;
(e) Machine operator, coke side;
(f) Benchman, coke side;
(g) Benchman, pusher side;
(h) Heater;
(i) Quenching car operator;
(j) Pusher machine operator;
(k) Screening station operator;
(l) Wharfman;
(m) Oven patcher;
(n) Oven repairman;
(o) Spellman; and
(p) Maintenance personnel.

Is the monitoring and measurement, as described above, repeated at least every three months? (e)(1)(iv)

Redetermination.

Is monitoring and measurement repeated for affected employees whenever there has been a production, process, or control change which may result in new or additional exposure to coke oven emissions, or whenever the employer has any other reason to suspect an increase in employee exposure? (e)(2)

	YES	NO
Employee Notification. (e)(3)		
Is each employee notified in writing of the exposure measurements which represent the employee's exposure? (e)(3)(i)		
Is such notification made within five working days after the receipt of results of measurements required by (e)(1) and (e)(2) of this section? (e)(3)(i)		
Whenever such results indicate that the representative employee exposure exceeds the permissible exposure limit, is each employee informed of that fact in the written notification? (e)(3)(ii)		
Are the corrective actions being taken to reduce exposure to or below the permissible exposure limit also included? (e)(3)(ii)		
Accuracy of Measurement.		
Does the method of monitoring and measurement used provide an accuracy (with a confidence level of 95%) of not less than plus or minus 35% for concentrations of coke oven emissions greater than or equal to 150 $\mu g/^3$? (e)(4)		
(f) Methods of Compliance (f)		
Priority of Compliance Method. (f)(1)		
Existing Coke Oven Batteries. (f)(1)(i)		
Has action been inititated to institute the engineering and work practice controls listed in (f)(2) thru (4) in existing coke oven batteries at the "earliest possible time," but not later than January 20, 1980? (Except to the extent that the employer can establish that such controls are not feasible.) (f)(1)(i)(a)		
Has the existing requirement to implement feasible controls to reduce exposures to coal tar pitch volatiles been considered in determining the "earliest possible time" for implementation of controls? (f)(1)(i)(a)		
Are engineering and work practice controls used to reduce exposures to the lowest level achievable even when that level still exceeds the permissible exposure limit? (f)(1)(i)(a)		
Is the use of respiratory protection, that complies with paragraph (g) of this section, required as a supplement when all feasible controls have been implemented and the permissible exposure limit is still exceeded? (f)(1)(i)(b)		
New or rehabilitated coke oven batteries. (f)(1)(ii)		
Have the best available engineering and work practice controls been initiated on all new or rehabilitated coke oven batteries (subsequent to January 20, 1977) to reduce and maintain employee exposures at or below the permissible exposure limit? (Not feasible controls excepted) (f)(1)(ii)(a)		
Are engineering and work practice controls used to reduce exposures to the lowest level achievable even when that level still exceeds the permissible exposure limit; and are they then supplemented by the use of respiratory protection which complies with the requirements of paragraph (g) of this section? (f)(1)(ii)(b)		

	YES	NO
Beehive Ovens. (f)(1)(iii)		
Have engineering and work practice controls been instituted at the "earliest possible time" to reduce and maintain employee exposures at or below the permissible exposure limit? (Not feasible controls excepted) (f)(1)(iii)(a)		
Has the existing requirement to implement feasible controls to reduce exposures to coal tar pitch volatiles been considered in determining the "earliest possible time" for implementation of controls? (f)(1)(iii)(a)		
Are engineering and work practice controls used to reduce exposures to the lowest level achievable even when that level still exceeds the permissible exposure limit; and are they then supplemented by the use of respiratory protection which complies with the requirements of paragraph (g) of this section? (f)(1)(iii)(b)		
Engineering Controls. (f)(2)		
Charging.		
Are existing coke oven batteries equipped and operated with all of the following engineering controls to control coke oven emissions during charging operations? (f)(2)(i)		
One of the following methods of charging:		
(1) Stage charging as described in paragraph (f)(3)(i)(b); or,		
(2) Sequential charging as described in paragraph (f)(3)(i)(b) except that paragraph (f)(3)(i)(b)(3)(iv) does not apply to sequential charging; or		
(3) Pipeline charging or other forms of enclosed charging in accordance with paragraph (f)(2)(i), except that paragraphs (f)(2)(i)(b), (d), (e), (f) and (h) do not apply. (f)(2)(i)(b)		
Drafting from two or more points in the oven being charged, through the use of double collector mains, or a fixed or moveable jumper pipe system to another oven, to effectively remove the gases from the oven to the collector mains;		
Aspiration systems designed and operated to provide sufficient negative pressure and flow volume to effectively move the gases evolved during charging into the collector mains, including sufficient steam pressure, and steam jets of sufficient diameter;		
Mechanical volumetric controls on each larry car hopper to provide the proper amount of coal to be charged through each charging hole so that the tunnel head will be sufficient to permit the gases to move from the oven into the collector mains;		
Devices to facilitate the rapid and continuous flow of coal into the oven being charged, such as stainless steel liners, coal vibrators or pneumatic shells;		
Individually operated larry car drop sleeves and slide gates designed and maintained so that the gases are effectively removed from the oven into the collector mains;		
Mechanized gooseneck and standpipe cleaners;		
Air seals on the pusher machine leveler bars to control air infiltration during charging; and		
Roof carbon cutters or a compressed air system or both on the pusher machine rams to remove roof carbon.		

1910.1029 – COKE OVEN EMISSIONS

	YES	NO

Coking.

Are existing coke oven batteries equipped and operated with all of the following engineering controls to control coke oven emissions during coking operation? **(f)(2)(ii)**

(a) A pressure control system on each battery to obtain uniform collector main pressure;

(b) Ready access to door repair facilities capable of prompt and efficient repair of doors, door sealing edges and all door parts;

(c) An adequate number of spare doors available for replacement purposes;

(d) Chuck door gaskets to control chuck door emissions until such door is repaired, or replaced; and

(e) Heat shields on door machines.

Work Practice Controls. **(f)(3)**

Charging.

Are existing coke oven batteries operated with all of the following work practices to control coke oven emissions during the charging operation? **(f)(3)(i)**

Establishment and implementation of a detailed, written inspection and cleaning procedure for each battery consisting of at least the following elements:

(1) Prompt and effective repair or replacement of all engineering controls;

(2) Inspection and cleaning of goosenecks and standpipes prior to each charge to a specified minimum diameter sufficient to effectively move the evolved gases from the oven to the collector mains;

(3) Inspection for roof carbon build-up prior to each charge and removal of roof carbon as necessary to provide an adequate gas channel so that the gases are effectively moved from the oven into the collector mains;

(4) Inspection of the steam aspiration system prior to each charge so that sufficient pressure and volume is maintained to effectively move the gases from the oven to the collector mains;

(5) Inspection of steam nozzles and liquor sprays prior to each charge and cleaning as necessary so that the steam nozzles and liquor sprays are clean;

(6) Inspection of standpipe caps prior to each charge and cleaning and luting or both as necessary so that the gases are effectively moved from the oven to the collector mains; and

(7) Inspection of charging holes and lids for cracks, warpage and other defects prior to each charge and removal of carbon to prevent emissions, and application of luting material to standpipe and charging hole lids where necessary to obtain a proper seal.

1910.1029 – COKE OVEN EMISSIONS

	YES	NO

Establishment and implementation of a detailed written charging procedure, designed and operated to eliminate emissions during charging for each battery, consisting of at least the following elements:

(1) Larry car hoppers filled with coal to a predetermined level in accordance with the mechanical volumetric controls required under paragraph (f)(2)(i)(d) of this section so as to maintain a sufficient gas passage in the oven to be charged;

(2) The larry car aligned over the oven to be charged, so that the drop sleeves fit tightly over the charging holes; and

(3) The oven charged in accordance with the following sequence of requirements:

(i) The aspiration system turned on;

(ii) Coal charged through the outermost hoppers, either individually or together, depending on the capacity of the aspiration system to collect the gases involved.

(iii) The charging holes used under paragraph (f)(3)(i)(b)(ii) relidded or otherwise sealed off to prevent leakage of coke oven emissions;

(iv) If four hoppers are used, the third hopper discharged and relidded or otherwise sealed off to prevent leakage of coke oven emissions;

(v) The final hopper discharged until the gas channel at the top of the oven is blocked and then the chuck door opened and the coal leveled;

(vi) When the coal from the final hopper is discharged and the leveling operation complete, the charging hole relidded or otherwise wealed off to prevent leakage of coke oven emissions; and

(vii) The aspiration system turned off only after the charging holes have been closed.

Establishment and implementation of a detailed written charging procedure, designed and operated to eliminate emissions during charging of each pipeline or enclosed charged battery.

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1910.1029 – COKE OVEN EMISSIONS

YES | NO

Coking.

Are existing coke oven batteries operated pursuant to a detailed written procedure established and implemented for the control of coke oven emissions during coking, consisting of at least the following elements? (f)(3)(ii)

(a) Checking oven back pressure controls to maintain uniform pressure conditions in the collecting main;

(b) Repair, replacement and adjustment of oven doors and chuck doors and replacement of door jambs so as to provide a continuous metal-to-metal fit;

(c) Cleaning of oven doors, chuck doors and door jambs each coking cycle so as to provide an effective seal;

(d) An inspection system and corrective action program to control door emissions to the maximum extent possible; and

(e) Luting of doors that are sealed by luting each coking cycle and reluting, replacing or adjusting as necessary to control leakage.

Pushing.

Are existing coke oven batteries operated with the following work practices to control coke oven emissions during pushing operations? (f)(3)(iii)

(a) Coke and coal spillage quenched as soon as practicable and not shoveled into a heated oven; and

(b) A detailed written procedure for each battery established and implemented for the control of emissions during pushing consisting of the following elements:

(1) Dampering off the ovens and removal of charging hole lids to effectively control coke oven emissions during the push;

(2) Heating of the coal charge uniformly for a sufficient period so as to obtain proper coking including preventing green pushes;

(3) Prevention of green pushes to the maximum extent possible;

(4) Inspection, adjustment and correction of heating flue temperatures and defective flues at least weekly and after any green push, so as to prevent green pushes;

(5) Cleaning of heating flues and related equipment to prevent green pushes, at least weekly and after any green push.

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YES | NO

Maintenance and Repair.

Are existing coke oven batteries operated pursuant to a detailed written procedure of maintenance and repair established and implemented for the effective control of coke oven emissions consisting of the following elements? (f)(3)(iv)

(a) Regular inspection of all controls, including goosenecks, standpipes, standpipe caps, charging hole lids and castings, jumper pipes and air seals for cracks, misalignment or other defects and prompt implementation of the necessary repairs as soon as possible;

(b) Maintaining the regulated area in a neat, orderly condition free of coal and coke spillage and debris;

(c) Regular inspection of the damper system, aspiration system and collector main for cracks or leakage, and prompt implementation of the necessary repairs;

(d) Regular inspection of the heating system and prompt implementation of the necessary repairs;

(e) Prevention of miscellaneous fugitive topside emissions;

(f) Regular inspection and patching of oven brickwork;

(g) Maintenance of battery equipment and controls in good working order.

(h) Maintenance and repair of coke oven doors, chuck doors, door jambs and seals; and

(i) Repairs instituted and completed as soon as possible, including temporary repair measures instituted and completed where necessary, including but not limited to:

(1) Prevention of miscellaneous fugitive topside emissions; and (f)(3)(iv)(i)(1)

(2) Chuck door gaskets, which shall be installed prior to the start of the next coking cycle. (f)(3)(iv)(i)(2)

Filter Air. (f)(4)

Has positive-pressure, temperature controlled filtered air been provided for larry car, pusher machine, door machine, and quenching car cabs? (f)(4)(i)

Have standby pulpits been provided on the battery topside, at the wharf and at the screening station and are they equipped with positive-pressure, temperature controlled filtered air? (f)(4)(ii)

Emergencies.

Whenever an emergency occurs, the next coking cycle may not begin until the cause of the emergency is determined and corrected, unless the employer can establish that it is necessary to initiate the next coking cycle in order to determine the cause of the emergency. (f)(5)

	YES	NO
Compliance Program. (f)(6)		
Has a written program to reduce exposures solely by means of the engineering and work practice controls been established and implemented? (f)(6)(i)		
Does the written program include at least the following? (f)(6)(ii)		
(a) A description of each coke oven operation by battery, including work force and operating crew, coking time, operating procedures and maintenance practices;		
(b) Engineering plans and other studies used to determine the controls for the coke battery;		
(c) A report of the technology considered in meeting the permissible exposure limit;		
(d) Monitoring data obtained in accordance with paragraph (e);		
(e) A detailed schedule for the implementation of the engineering and work practice controls specified in paragraph (f); and		
(f) Other relevant information.		
(g) Respiratory Protection (g)(1)		
General.		
Are you aware that compliance with the permissible exposure limit may not be achieved by the use of respirators except in the following instances? (g)(1)(i)		
(a) During the time period necessary to install or implement feasible engineering and work practice controls; or		
(b) In work operations such as maintenance and repair activity in which engineering and work practice controls are technologically not feasible; or		
(c) In work situations where feasible engineering and work practice controls are not yet sufficient to reduce exposure to or below the permissible exposure limit; or		
(d) In emergencies.		
Is it recognized that notwithstanding any other requirement of this section, until January 20, 1978, the wearing of respirators shall be at the discretion of each employee where the employee is not in the vicinity of visible emissions? (g)(1)(ii)		
If after implementing all controls required by paragraphs (f)(2) thru (f)(4), or after January 20, 1980, whichever is sooner, or after completion of a new or rehabilitated battery, the permissible exposure limit is still exceeded the following applies: (f)(6)(iii)		
Has a detailed written program and schedule for the development and implementation of any additional engineering controls and work practices necessary to reduce exposure to or below the permissible exposure limit been developed? (f)(6)(iii)		
Is the written plan for such program available at the worksite for examination and copying by the Secretary, the Director, and the authorized employee representative? (f)(6)(iv)		

	YES	NO
Training in Compliance Procedures.		
Have all the written procedures and schedules required under (f) been incorporated in the information and training program required under (k) of this section and, where appropriate, posted in the regulated area? (f)(7)		
Selection.		
Where respirators are required, has Table 1 been used in selecting the proper respirator? (g)(2)(i)		
Is the appropriate respirator or combination of respirators provided and their use assured? (g)(2)(i)		
Is either a particulate filter respirator or a powered air purifying respirator as listed in Table 1 provided, at the option of each affected employee, whenever respirators are required for concentrations not greater than 1500 $\mu g/m^3$? (g)(2)(ii)		
Have the respirators been approved by the National Institute for Occupational Safety and Health (NIOSH) in accordance with the following? (g)(2)(iii)		
The employer shall select respirators from among those approved for protection against dust and mist.		
No later than January 20, 1979, the employer shall select respirators from among those approved for protection against coke oven emissions.		
Respirator Program.		
Is the respirator program in accordance with 1910.134? (g)(3)		
Respirator Usage.		
Are necessary steps taken to assure that the respirator issued to the employee exhibits minimum facepiece leakage and that the respirator is fitted properly? (g)(4)(i)		
Are quantitative fit tests performed annually for each employee who uses a nonpowered, particulate filter respirator? (g)(4)(i)		
Is each employee who uses a filter respirator allowed to change the filter elements whenever an increase in breathing resistance is detected and is an adequate supply of filter elements maintained for this purpose? (g)(4)(ii)		
Are employees who wear respirators allowed to wash their face and respirator facepiece to prevent skin irritation associated with respirator use? (g)(4)(iii)		
(h) Protective Clothing and Equipment		
Provision and Use.		
Has the employer provided and assured the use of appropriate protective clothing and equipment, such as but not limited to the following? (h)(1)		
(i) Flame resistant jacket and pants;		
(ii) Flame resistant gloves;		
(iii) Face shields or vented goggles which comply with §1910.133(a)(2) of this part;		
(iv) Insulation from hot surfaces for footwear;		
(v) Safety shoes which comply with §1910.136 of this part; and		
(vi) Protective helmets which comply with §1910.135 of this part.		

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	YES	NO
Cleaning and Replacement. (h)(2)		
Are flame resistant jackets, pants, and gloves provided in a clean and dry condition at least weekly; and does the employer clean, launder or dispose of this protective clothing as required? (h)(2)(i)&(ii)		
Is the protective clothing and equipment repaired or replaced as needed to maintain their effectiveness? (h)(2)(iii)		
Is all protective clothing removed at the completion of a work shift only in change rooms prescribed in paragraph (i)(1)? (h)(2)(iv)		
Is contaminated protective clothing which is to be cleaned, laundered, or disposed of, placed in a closable container in the change room? (h)(2)(v)		
Is any person who cleans or launders this protective clothing informed of the potentially harmful effects of exposure to coke oven emissions? (h)(2)(vi)		
(i) Hygiene Facilities and Practices (i)		
Change Rooms.		
Are clean change rooms equipped with storage facilities for street clothes and separate storage facilities for protective clothing and equipment provided whenever employees are required to wear protective clothing and equipment in accordance with paragraph (h)(1)? (i)(1)		
Showers. (i)(2)		
Do employees working in the regulated area shower at the end of the work shift? (i)(2)(i)		
Are shower facilities provided in accordance with 1910.141(d)(3)? (i)(2)(ii)		
Lunchrooms.		
Are lunchroom facilities provided which have a temperature controlled, positive pressure, filtered air supply, and which are readily accessible to employees working in the regulated area? (i)(3)		
Lavatories. (i)(4)		
Do employees working in the regulated area wash their hands and face prior to eating? (i)(4)(i)		
Are lavatory facilities provided in accordance with 1910.141(d)(1) and paragraph (i)(2) of this section? (i)(4)(ii)		
Prohibition of Activities in the Regulated Area. (i)(5)		
Does the employer assure that in the regulated area, food or beverages are not present or consumed, smoking products are not present or used, and cosmetics are not applied? (i)(5)(i)		
Note: Drinking water may be consumed in the regulated area. (i)(5)(ii)		
(j) Medical Surveillance (j)		
General Requirements. (j)(1)		
Has a medical surveillance program been instituted for all employees who are employed in a regulated area at least 30 days per year? (j)(1)(i)		

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	YES	NO
Does the program provide each employee so covered with an opportunity for medical examination in accordance with this paragraph (j)? (j)(1)(ii)		
Are employees who refuse any required medical examination informed of the possible health consequences of such refusal and has a signed statement been obtained indicating that the employee understands the risk involved in such refusal? (j)(1)(iii)		
Are all medical examinations and procedures performed by or under the supervision of a licensed physician, and are they provided without cost to the employee? (j)(1)(iv)		
Initial Examinations.		
At the time of initial assignment to a regulated area or upon the institution of the medical surveillance program, has a medical examination, that includes at least the following elements, been provided for employees who work in the regulated area at least 30 days per year? (j)(2)		
(i) A work history and medical history which shall include smoking history and the presence and degree of respiratory symptoms, such as breathlessness, cough, sputum production, and wheezing;		
(ii) A 14" X 17" posterior-anterior chest x-ray and International Labour Office UICC/Cincinnati (ILO U/C) rating;		
(iii) Pulmonary function tests including forced vital capacity (FVC) and forced expiratory volume at one second (FEV 1.0) with recording of type of equipment used;		
(iv) Weight;		
(v) A skin examination;		
(vi) Urinalysis for sugar, albumin, and hematuria;		
(vii) A sputum cytology examination; and		
(viii) A urinary cytology examination.		
Periodic Examinations. (j)(3)		
Is the examination specified in (j)(2)(i) thru (vi) provided at least annually for employees who work in the regulated area at least 30 days per year? (j)(3)(i)		
Is the examination specified in (j)(2)(i) thru (vii) provided at least semi-annually for employees 45 years of age or older or with five (5) or more years employment in the regulated area? (j)(3)(ii)		
Is it recognized that whenever an employee who is 45 years of age or older or with five (5) or more years employment in the regulated area transfers or is transferred from employment in a regulated area, the employer shall continue to provide the examinations specified in (j)(3)(ii) above as long as that employee is employed by the same employer or a successor employer? (j)(3)(iii)		
Is it recognized that whenever an employee has not taken the required examination within the six (6) months preceding the termination of employment, the employer shall provide such examination to the employee upon termination of employment. (j)(3)(iv)		

	YES	NO

Information Provided to the Physician.

Does the employer provide the following information to the examining physician? (j)(4)

(i) A copy of this regulation and its Appendixes;

(ii) A description of the affected employee's duties as they relate to the employee's exposure;

(iii) The employee's exposure level or estimated exposure level;

(iv) A description of any personal protective equipment used or to be used; and

(v) Information from previous medical examinations of the affected employee which is not readily available to the examining physician.

Physician's Written Opinion. (j)(5)

Is a written opinion obtained from the examining physician which includes the following? (j)(5)(i)

(a) The results of the medical examinations;

(b) The physician's opinion as to whether the employee has any detected medical conditions which would place the employee at increased risk of material impairment of the employee's health from exposure to coke oven emissions;

(c) Any recommended limitations upon the employee's exposure to coke oven emissions or upon the use of protective clothing or equipment such as respirators; and

(d) A statement that the employee has been informed by the physician of the results of the medical examination and any medical conditions which require further explanation or treatment.

Is the physician instructed not to reveal in the written opinion specific findings or diagnoses unrelated to occupational exposure? (j)(5)(ii)

Is a copy of the written opinion provided the affected employee? (j)(5)(iii)

(k) Employee Information and Training (k)

Training Program. (k)(1)

Has a training program been instituted for employees who are employed in the regulated area and has their participation been assured? (k)(1)(i)

Note: Training program is required as of January 27, 1977 (k)(1)(ii)

Is the training program provided at least annually for all employees who are employed in the regulated area, except that training regarding the occupational safety and health hazards associated with exposure to coke oven emissions and the purpose, proper use, and limitations of respiratory protective devices shall be provided at least quarterly until January 20, 1978? (k)(1)(iii)

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	YES	NO

Does the training program include informing each employee of the following? (k)(1)(iv)

(a) The information contained in the substance information sheet for coke oven emissions (Appendix A); (see page

(b) The purpose, proper use, and limitations of respiratory protective devices required in accordance with paragraph (g) of this section;

(c) The purpose for and a description of the medical surveillance program required by paragraph (j) of this section including information on the occupational safety and health hazards associated with exposure to coke oven emissions;

(d) A review of all written procedures and schedules required under paragraph (f) of this section; and

(e) A review of this standard.

Access to Training Materials. (k)(2)

Is a copy of the Coke Oven Emission standard and its appendixes readily available to all employees who are employed in the regulated area? (k)(2)(i)

Is it recognized that the employer must provide upon request all materials relating to the employee information and training program to the Secretary and the Director? (k)(2)(ii)

(l) Precautionary Signs and Labels (1)

General. (l)(1)

Note: Employers may use labels or signs required by other statutes, regulations or ordinances in addition to, or in combination with signs and labels required herein. (l)(1)(i)

Does the employer assure that no statement appears on or near any sign required by this paragraph which contradicts or detracts from the effects of the required sign? (l)(1)(ii)

Are signs required by this paragraph illuminated and cleaned as necessary so that the legend is readily visible? (l)(1)(iii)

Signs. (l)(2)

Are signs posted in the regulated area bearing the legends? (l)(2)(i)

DANGER

CANCER HAZARD

AUTHORIZED PERSONNEL ONLY

NO SMOKING OR EATING

Is it recognized that in addition, not later than January 20, 1978, the employer shall post signs in the areas where the permissible exposure limit is exceeded bearing the legend? (l)(2)(ii)

DANGER

RESPIRATOR REQUIRED

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	YES	NO
Labels.		
Are precautionary labels applied to all containers of protective clothing contaminated with coke oven emissions bearing the legend? (l)(3)		
CAUTION		
CLOTHING CONTAMINATED WITH COKE EMISSIONS		
DO NOT REMOVE DUST BY BLOWING OR SHAKING		
(m) Recordkeeping (m)		
Exposure Measurements. (m)(1)		
Has an accurate record been established and maintained of all measurements taken to monitor employee exposure to coke oven emissions required in paragraph (e) and does it include the following? (m)(1)(i)		
(a) Name, social security number, and job classification of the employees monitored;		
(b) The date(s), number, duration and results of each of the samples taken, including a description of the sampling procedure used to determine representative employee exposure where applicable;		
(c) The type of respiratory protective devices worn, if any;		
(d) A description of the sampling and analytical methods used and evidence of their accuracy; and		
(e) The environmental variables that could affect the measurement of employee exposure.		
Is it recognized that the employer shall maintain this record for at least 40 years or for the duration of employment plus 20 years, whichever is longer? (m)(1)(ii)		
Medical Surveillance. (m)(2)		
Has an accurate record been established and maintained for each employee subject to medical surveillance as required by paragraph (j) and does it include the following? (m)(2)(i)		
(a) The name, social security number, and description of duties of the employee;		
(b) A copy of the physician's written opinion;		
(c) The signed statement of any refusal to take a medical examination under paragraph (j)(1)(ii) of this section; and		
(d) Any employee medical complaints related to exposure to coke oven emissions.		

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	YES	NO
Does the employer keep, or has he assured that the examining physician keeps the following medical records? (m)(2)(ii)		
(a) A copy of the medical examination results including medical and work history required under paragraph (j)(2) of this section;		
(b) A description of the laboratory procedures used and a copy of any standards or guidelines used to interpret the test results;		
(c) The initial x-rays;		
(d) The x-rays for the most recent 5 years;		
(e) Any x-ray with a demonstrated abnormality and all subsequent x-rays;		
(f) The initial cytologic examination slide and written description;		
(g) The cytologic examination slide and written description for the most recent 10 years; and		
(h) Any cytologic examination slides with demonstrated atypia, if such atypia persists for 3 years, and all subsequent slides and written descriptions.		
Is it recognized that the employer must maintain the required medical records for at least 40 years, or for the duration of employment plus 20 years, whichever is longer? (m)(2)(iii)		
Availability. (m)(3)		
Is the employer aware of his obligation to make available upon request, all records required to be maintained by paragraph (m) to the Secretary and the Director for examination and copying? (m)(3)(i)		
Is the employer aware of his obligation to make available upon request, records of employee exposure measurements, for inspection and copying to affected employees, and their designated representatives? (m)(3)(ii)		
Are employee medical records required by paragraph (m)(2) made available, upon request, to a physician designated by the affected employee or former employee? (m)(3)(iii)		
Are employee exposure measurement records, required by paragraph (m)(1), made available for inspection and copying to former employees and their designated representatives which indicate the former employees' own exposures? (m)(3)(iv)		

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	YES	NO
Transfer of Records. (m)(4)		
Is it recognized that whenever the employer ceases to do business, the successor employer shall receive and retain all records required to be maintained by paragraph (m)? **(m)(4)(i)**		
Note: Whenever there is no successor employer to receive and retain the records for the prescribed period, these records shall be transmitted by registered mail to the Director. **(m)(4)(ii)**		
Is the employer aware of his obligation, at the end of the retention period, to either transmit to the Director or continue to retain the records of exposure measurements and medical surveillance required by (m)(1) and (m)(2)? **(m)(4)(iii)**		
(n) Observation of Monitoring **(n)**		
Employee Observation.		
Are affected employees or their representatives provided an opportunity to observe any measuring or monitoring of employee exposure to coke oven emissions conducted pursuant to paragraph (e)? **(n)(1)**		
Observation Procedures. **(n)(2)**		
Are observers provided necessary protective clothing and equipment and required to comply with all other applicable safety and health procedures whenever entering areas where such equipment is required? **(n)(2)(i)**		
Without interfering with the measurement, have observers been entitled to the following? **(n)(2)(ii)**		
(a) An explanation of the measurement procedures;		
(b) Observe all steps related to the measurement of coke oven emissions performed at the place of exposure; and		
(c) Record the results obtained.		

	YES	NO

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1910.1030 — BLOODBORNE PATHOGENS

[Added 1992]

(a) Scope and Application

This section applies to all occupational exposure to blood or other potentially infectious materials as defined by paragraph (b) of this section.

(b) Definitions

See page Z-iii

(c) Exposure Control

Exposure Control Plan

Has each employer having an employee(s) with occupational exposure as defined by paragraph (b) of this section established a written Exposure Control Plan designed to eliminate or minimize employee exposure? **(c)(1)(i)**

Does the Exposure Control Plan contain at least the following elements:

- The exposure determination required by paragraph (c)(2)? **(c)(1)(ii)(A)**
- The schedule and method of implementation for the paragraphs (d) Methods of Compliance, (e) HIV and HBV Research Laboratories and Production Facilities, (f) Hepatitis B Vaccination and Post-Exposure Evaluation and Follow-up, (g) Communication of Hazards to Employees, and (h) Recordkeeping, of this standard, **(c)(1)(ii)(B)**

AND

- The procedure for the evaluation of circumstances surrounding exposure incidents as required by paragraph (f)(3)(i) of this standard? **(c)(1)(ii)(C)**

Does each employer ensure that a copy of the Exposure Control Plan is accessible to employees in accordance with 29 CFR 1910.20 (e)? **(c)(1)(iii)**

Is the Exposure Control Plan reviewed and updated at least annually? **(c)(1)(iv)**

Is the Exposure Control Plan reviewed and updated whenever necessary to reflect new or modified tasks and procedures that affect occupational exposure and to reflect new or revised employee positions with occupational exposure? **(c)(1)(iv)**

Is the Exposure Control Plan made available to the Assistant Secretary and the Director upon request for examination and copying? **(c)(1)(v)**

Exposure Determination

Has each employer who has an employee(s) with occupational exposure as defined by paragraph (b) of this section prepared an exposure determination? **(c)(2)(i)**

Does this exposure determination contain the following:

- A list of all job classifications in which all employees in those job classifications have occupational exposure; **(c)(2)(i)(A)**

YES	NO

1910.1030 — BLOODBORNE PATHOGENS

- A list of job classifications in which some employees have occupational exposure, **(c)(2)(i)(B)**

AND

- A list of all tasks and procedures or groups of closely related task and procedures in which occupational exposure occurs and that are performed by employees in job classifications listed in accordance with the provisions of paragraph (c)(2)(i)(B) of this standard? **(c)(2)(i)(C)**

Is this exposure determination made without regard to the use of personal protective equipment? **(c)(2)(ii)**

(d) Methods of Compliance

General

Are universal precautions observed to prevent contact with blood or other potentially infectious materials? **(d)(1)**

Under circumstances in which differentiation between body fluid types is difficult or impossible, are all body fluids considered potentially infectious materials? **(d)(1)**

Engineering and Work Practice Controls

Are engineering and work practice controls used to eliminate or minimize employee exposure? **(d)(2)(i)**

Where occupational exposure remains after institution of these controls, is personal protective equipment also used? **(d)(2)(i)**

Are engineering controls examined and maintained or replaced on a regular schedule to ensure their effectiveness? **(d)(2)(ii)**

Do employers provide handwashing facilities which are readily accessible to employees? **(d)(2)(iii)**

When provision of handwashing facilities is not feasible, does the employer provide either an appropriate antiseptic hand cleanser in conjunction with clean cloth/paper towels or antiseptic towelettes? **(d)(2)(iv)**

When antiseptic hand cleansers or towelettes are used, are hands washed with soap and running water as soon as feasible? **(d)(2)(iv)**

Does the employer ensure that employees wash their hands immediately or as soon as feasible after removal of gloves or other personal protective equipment? **(d)(2)(v)**

Does the employer ensure that employees wash hands and any other skin with soap and water, or flush mucous membranes with water immediately or as soon as feasible following contact of such body areas with blood or other potentially infectious materials? **(d)(2)(vi)**

Are contaminated needles and other contaminated sharps not allowed to be bent, recapped or removed except as noted in paragraphs (d)(2)(vii)(A) and (d)(2)(vii)(B) below? **(d)(2)(vii)**

Is shearing or breaking of contaminated needles prohibited? **(d)(2)(vii)**

Are contaminated needles and other contaminated sharps not allowed to be recapped or removed unless the employer can demonstrate that no alternative is feasible or that such action is required by a specific medical procedure? **(d)(2)(vii)(A)**

	YES	NO
Is such recapping or needle removal accomplished through the use of a mechanical device or a one-handed technique? (d)(2)(vii)(B)		
Immediately or as soon as possible after use, are contaminated reusable sharps placed in appropriate containers until properly reprocessed? (d)(2)(viii)		
Are these containers:		
• Puncture resistant; (d)(2)(viii)(A)		
• Labeled or color-coded in accordance with this standard; (d)(2)(viii)(B)		
• Leakproof on the sides and bottom; (d)(2)(viii)(C)		
AND		
• In accordance with the requirements set forth in paragraph (d)(4)(ii)(E) for reusable sharps? (d)(2)(viii)(D)		
Are eating, drinking, smoking, applying cosmetics or lip balm, and handling contact lenses prohibited in work areas where there is a reasonable likelihood of occupational exposure? (d)(2)(ix)		
Are food and drink not allowed to be kept in refrigerators, freezers, shelves, cabinets or on countertops or benchtops where blood or other potentially infectious materials are present? (d)(2)(x)		
Are all procedures involving blood or other potentially infectious materials performed in such a manner as to minimize splashing, spraying, spattering, and generation of droplets of these substances? (d)(2)(xi)		
Is mouth pipetting/suctioning of blood or other potentially infectious materials prohibited? (d)(2)(xii)		
Are specimens of blood or other potentially infectious materials placed in a container which prevents leakage during collection, handling, processing, storage, transport or shipping? (d)(2)(xiii)		
Is the container for storage, transport, or shipping labeled or color-coded according to paragraph (g)(1)(i) and closed prior to being stored, transported or shipped? (d)(2)(xiii)(A)		
When a facility utilizes Universal Precautions in the handling of all specimens, the labeling/color-coding of specimens is not necessary provided containers are recognizable as containing specimens. This exemption only applies while such specimens/containers remain within the facility. Labeling or color-coding in accordance with paragraph (g)(1)(i) is required when such specimens/containers leave the facility. (d)(2)(xiii)(A)		
If outside contamination of the primary container occurs, is the primary container placed within a second container which prevents leakage during handling, processing, storage, transport or shipping? (d)(2)(xiii)(B)		
Is the second container labeled or color-coded according to the requirements of this standard? (d)(2)(xiii)(B)		
If the specimen could puncture the primary container, is the primary container placed within a secondary container which is puncture-resistant in addition to the above characteristics? (d)(2)(xiii)(C)		
Is equipment which may become contaminated with blood or other potentially infectious materials examined prior to servicing or shipping? (d)(2)(xiv)		

	YES	NO
Is the equipment decontaminated as necessary, unless the employer can demonstrate that decontamination of such equipment or portions of such equipment is not feasible? (d)(2)(xiv)		
Is a readily observable label in accordance with paragraph (g)(1)(i)(H) attached to the equipment, stating which portions remain contaminated? (d)(2)(xiv)(A)		
Has the employer ensured that this information is conveyed to all affected employees, the servicing representative, and/or the manufacturer, as appropriate, prior to handling, servicing, or shipping so that appropriate precautions will be taken? (d)(2)(xiv)(B)		
Personal protective equipment		
Provision		
When there is occupational exposure, does the employer provide, at no cost to the employee, appropriate personal protective equipment such as, but not limited to, gloves, gowns, laboratory coats, face shields or masks and eye protection, and mouthpieces, resuscitation bags, pocket masks, or other ventilation devices? (d)(3)(i)		
Personal protective equipment will be considered "appropriate" only if it does not permit blood or other potentially infectious materials to pass through to or reach the employee's work clothes, street clothes, undergarments, skin, eyes, mouth, or other mucous membranes under normal conditions of use and for the duration of time which the protective equipment will be used. (d)(3)(i)		
Use		
Does the employer ensure that the employee uses appropriate personal protective equipment unless the employer shows that the employee temporarily and briefly declined to use personal protective equipment when, under rare and extraordinary circumstances, it was the employee's professional judgment that in the specific instance its use would have prevented the delivery of health care or public safety services or would have posed an increased hazard to the safety of the worker or co-worker? (d)(3)(ii)		
When the employee makes this judgement, are the circumstances investigated and documented in order to determine whether changes can be instituted to prevent such occurrences in the future? (d)(3)(ii)		
Accessibility		
Does the employer ensure that appropriate personal protective equipment in the appropriate sizes is readily accessible at the worksite or is issued to employees? (d)(3)(iii)		
Are hypoallergenic gloves, glove liners, powderless gloves, or other similar alternatives readily accessible to those employees who are allergic to the gloves normally provided? (d)(3)(iii)		
Cleaning, Laundering and Disposal		
Does the employer clean, launder, and dispose of personal protective equipment required by paragraphs (d) and (e) of this standard, at no cost to the employee? (d)(3)(iv)		

	YES	NO
Repair and Replacement		
Does the employer repair or replace personal protective equipment as needed to maintain its effectiveness, at no cost to the employee? **(d)(3)(v)**		
If a garment(s) is penetrated by blood or other potentially infectious materials, is the garment(s) removed immediately or as soon as feasible? **(d)(3)(vi)**		
Is all personal protective equipment removed prior to leaving the work area? **(d)(3)(vii)**		
When personal protective equipment is removed, is it placed in an appropriately designated area or container for storage, washing, decontamination or disposal? **(d)(3)(viii)**		
Gloves		
Are gloves worn when it can be reasonably anticipated that the employee may have hand contact with blood, other potentially infectious materials, mucous membranes, and non-intact skin? **(d)(3)(ix)**		
Are gloves worn when performing vascular access procedures except as specified in paragraph (d)(3)(ix)(D); and when handling or touching contaminated items or surfaces? **(d)(3)(ix)**		
Are disposable (single use) gloves such as surgical or examination gloves, replaced as soon as practical when contaminated or as soon as feasible if they are torn, punctured, or when their ability to function as a barrier is compromised? **(d)(3)(ix)(A)**		
Are disposable (single use) gloves not allowed to be washed or decontaminated for re-use? **(d)(3)(ix)(B)**		
Utility gloves may be decontaminated for re-use if the integrity of the glove is not compromised. However, they must be discarded if they are cracked, peeling, torn, punctured, or exhibit other signs of deterioration or when their ability to function as a barrier is compromised. **(d)(3)(ix)(C)**		
If an employer in a volunteer blood donation center judges that routine gloving for all phlebotomies is not necessary then the employer must:		
(1) Periodically reevaluate this policy;		
(2) Make gloves available to all employees who wish to use them for phlebotomy;		
(3) Not discourage the use of gloves for phlebotomy;		
AND		
(4) Require that gloves be used for phlebotomy in the following circumstances:		
(i) When the employee has cuts, scratches, or other breaks in his or her skin;		
(ii) When the employee judges that hand contamination with blood may occur, for example, when performing phlebotomy on an uncooperative source individual;		
AND		
(iii) When the employee is receiving training in phlebotomy. **(d)(3)(ix)**		

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	YES	NO
Masks, Eye Protection and Face Shields		
Are masks in combination with eye protection devices, such as goggles or glasses with solid side shields, or chin-length face shields, worn whenever splashes, spray, spatter, or droplets of blood or other potentially infectious materials may be generated and eye, nose, or mouth contamination can be reasonably anticipated? **(d)(3)(x)**		
Gowns, Aprons and Other Protective Body Clothing		
Is appropriate protective clothing such as, but not limited to, gowns, aprons, lab coats, clinic jackets or similar outer garments worn in occupational exposure situations? **(d)(3)(xi)**		
The type and characteristics will depend upon the task and degree of exposure anticipated. **(d)(3)(xi)**		
Are surgical caps or hoods and/or shoe covers or boots worn in instances when gross contamination can reasonably be anticipated (e.g., autopsies, orthopaedic surgery)? **(d)(3)(xii)**		
Housekeeping		
General		
Do employers ensure that the worksite is maintained in a clean and sanitary condition? **(d)(4)(i)**		
Has the employer determined and implemented an appropriate written schedule for cleaning and method of decontamination based upon the location within the facility, type of surface to be cleaned, type of soil present, and tasks or procedures being performed in the area? **(d)(4)(i)**		
Are all equipment and environmental and working surfaces cleaned and decontaminated after contact with blood or other potentially infectious materials? **(d)(4)(ii)**		
Are contaminated work surfaces decontaminated with an appropriate disinfectant after completion of procedures? **(d)(4)(ii)(A)**		
Are contaminated work surfaces decontaminated with an appropriate disinfectant immediately or as soon as feasible when surfaces are overtly contaminated or after any spill of blood or other potentially infectious materials? **(d)(4)(ii)(A)**		
Are contaminated work surfaces decontaminated with an appropriate disinfectant at the end of the work shift if the surface may have become contaminated since the last cleaning? **(d)(4)(ii)(A)**		
Are protective coverings, such as plastic wrap, aluminum foil, or imperviously-backed absorbent paper used to cover equipment and environmental surfaces, removed and replaced as soon as feasible when they become overtly contaminated or at the end of the workshift if they may have become contaminated during the shift? **(d)(4)(ii)(B)**		
Are all bins, pails, cans, and similar receptacles intended for reuse which have a reasonable likelihood for becoming contaminated with blood or other potentially infectious materials inspected and decontaminated on a regularly scheduled basis and cleaned and decontaminated immediately or as soon as feasible upon visible contamination? **(d)(4)(ii)(C)**		

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	YES	NO
Is broken glassware which may be contaminated not allowed to be picked up directly with the hands? (d)(4)(ii)(D)		
Is broken glassware cleaned up using mechanical means, such as a brush and dust pan, tongs, or forceps? (d)(4)(ii)(D)		
Are reusable sharps contaminated with blood or other potentially infectious materials not allowed to be stored or processed in a manner that requires employees to reach by hand into the containers where these sharps have been placed? (d)(4)(ii)(E)		
Regulated Waste		
Contaminated Sharps Discarding and Containment		
Are contaminated sharps discarded immediately or as soon as feasible in containers that are: • Closable; • Puncture resistant; • Leakproof on sides and bottom; **AND** • Labeled or color-coded in accordance with paragraph (g)(1)(i) of this standard? (d)(4)(iii)(A)(1)		
During use, are containers for contaminated sharps: • Easily accessible to personnel and as close as is feasible to the immediate area where sharps are used or can be reasonably anticipated to be found (e.g., laundries); • Maintained upright throughout use; **AND** • Replaced routinely and not allowed to be overfilled? (d)(4)(iii)(A)(2)		
When moving containers of contaminated sharps from the area of use, are the containers: • Closed immediately prior to removal or replacement to prevent spillage or protrusion of contents during handling, storage, transport, or shipping: **AND** • Placed in a secondary container if leakage is possible? (d)(4)(iii)(A)(3)		
Is the second container: • Closable; • Constructed to contain all contents and prevent leakage during handling, storage, transport, or shipping; **AND** • Labeled or color-coded according to paragraph (g)(1)(i) of this standard? (d)(4)(iii)(A)(3)		
Are reusable containers not allowed to be opened, emptied, or cleaned manually or in any other manner which would expose employees to the risk of percutaneous injury? (d)(4)(iii)(A)(4)		

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	YES	NO
Other Regulated Waste Containment		
Is regulated waste placed in containers which are: • Closable; • Constructed to contain all contents and prevent leakage of fluids during handling, storage, transport or shipping; • Labeled or color-coded in accordance with paragraph (g)(1)(i) this standard; **AND** • Closed prior to removal to prevent spillage or protrusion of contents during handling, storage, transport, or shipping? (d)(4)(iii)(B)(1)		
If outside contamination of the regulated waste container occurs, is it placed in a second container? (d)(4)(iii)(B)(2)		
Is the second container: • Closable; • Constructed to contain all contents and prevent leakage of fluids during handling, storage, transport or shipping; • Labeled or color-coded in accordance with paragraph (g)(1)(i) of this standard; **AND** • Closed prior to removal to prevent spillage or protrusion of contents during handling, storage, transport, or shipping? (d)(4)(iii)(B)(2)		
Is disposal of all regulated waste in accordance with applicable regulations of the United States, States and Territories, and political subdivisions of States and Territories? (d)(4)(iii)(C)		
Laundry		
Is contaminated laundry handled as little as possible with a minimum of agitation? (d)(4)(iv)(A)		
Is contaminated laundry bagged or containerized at the location where it was used and not sorted or rinsed in the location of use? (d)(4)(iv)(A)(1)		
Is contaminated laundry placed and transported in bags or containers labeled or color-coded in accordance with paragraph (g)(1)(i) of this standard? (d)(4)(iv)(A)(2)		
When a facility utilizes Universal Precautions in the handling of all soiled laundry, alternative labeling or color-coding is sufficient if it permits all employees to recognize the containers as requiring compliance with Universal Precautions. (d)(4)(iv)(A)(2)		
Whenever contaminated laundry is wet and presents a reasonable likelihood of soak-through of or leakage from the bag or container, is the laundry placed and transported in bags or containers which prevent soak-through and/or leakage of fluids to the exterior? (d)(4)(iv)(A)(3)		
Does the employer ensure that employees who have contact with contaminated laundry wear protective gloves and other appropriate personal protective equipment? (d)(4)(iv)(B)		
When a facility ships contaminated laundry off-site to a second facility which does not utilize Universal Precautions in the handling of all laundry, does the facility generating the contaminated laundry place such laundry in bags or containers which are labeled or color-coded in accordance with paragraph (g)(1)(i)? (d)(4)(iv)(C)		

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YES	NO

(e) HIV and HBV Research Laboratories and Production Facilities

This paragraph applies to research laboratories and production facilities engaged in the culture, production, concentration, experimentation, and manipulation of HIV and HBV. It does not apply to clinical or diagnostic laboratories engaged solely in the analysis of blood, tissues, or organs. These requirements apply in addition to the other requirements of the standard. **(e)(1)**

Do research laboratories and production facilities meet the following criteria:

Standard microbiological practices **AND** special practices? **(e)(2)(i,ii)**

Standard Practices

Are all regulated waste either incinerated or decontaminated by a method such as autoclaving known to effectively destroy bloodborne pathogens? **(e)(2)(i)**

Special Practices

Are laboratory doors kept closed when work involving HIV or HBV is in progress? **(e)(2)(ii)(A)**

Are contaminated materials that are to be decontaminated at a site away from the work area placed in a durable, leakproof, labeled or color-coded container that is closed before being removed from the work area? **(e)(2)(ii)(B)**

Is access to the work area limited to authorized persons? **(e)(2)(ii)(C)**

Have written policies and procedures been established whereby only persons who have been advised of the potential biohazard, who meet any specific entry requirements, and who comply with all entry and exit procedures are allowed to enter the work areas and animal rooms? **(e)(2)(ii)(C)**

When other potentially infectious materials or infected animals are present in the work area or containment module, is a hazard warning sign incorporating the universal biohazard symbol posted on all access doors? **(e)(2)(ii)(D)**

Does the hazard warning sign comply with paragraph (g)(1)(ii) of this standard? **(e)(2)(ii)(D)**

Are all activities involving other potentially infectious materials conducted in biological safety cabinets or other physical-containment devices within the containment module? **(2)(2)(ii)(E)**

Is work with these other potentially infectious materials not allowed to be conducted on the open bench? **(e)(2)(ii)(E)**

Are laboratory coats, gowns, smocks, uniforms, or other appropriate protective clothing used in the work area and animal rooms? **(e)(2)(ii)(F)**

Is protective clothing not allowed to be worn outside of the work area and decontaminated before being laundered? **(e)(2)(ii)(F)**

Is special care taken to avoid skin contact with other potentially infectious materials? **(e)(2)(ii)(G)**

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YES	NO

Are gloves worn when handling infected animals and when making hand contact with other potentially infectious materials is unavoidable? **(e)(2)(ii)(G)**

Before disposal, is all waste from work areas and from animal rooms either incinerated or decontaminated by a method such as autoclaving known to effectively destroy bloodborne pathogens? **(e)(2)(ii)(H)**

Are vacuum lines protected with liquid disinfectant traps and high-efficiency particulate air (HEPA) filters or filters of equivalent or superior efficiency? **(e)(2)(ii)(I)**

Are these traps and air filters checked routinely and maintained or replaced as necessary? **(e)(2)(ii)(I)**

Are hypodermic needles and syringes used only for parenteral injection and aspiration of fluids from laboratory animals and diaphragm bottles? **(e)(2)(ii)(J)**

Are only needle-locking syringes or disposable syringe-needle units (i.e., the needle is integral to the syringe) used for the injection or aspiration of other potentially infectious materials? **(e)(2)(ii)(J)**

Extreme caution must be used when handling needles and syringes. A needle should not be bent, sheared, replaced in the sheath or guard, or removed from the syringe following use. The needle and syringe should be promptly placed in a puncture-resistant container and autoclaved or decontaminated before reuse or disposal. **(e)(2)(ii)(J)**

Are all spills immediately contained and cleaned up by appropriate professional staff or others properly trained and equipped to work with potentially concentrated infectious materials? **(e)(2)(ii)(K)**

Is a spill or accident that results in an exposure incident immediately reported to the laboratory director or other responsible person? **(e)(2)(ii)(L)**

Has a biosafety manual been prepared or adopted and periodically reviewed and updated at least annually or more often if necessary? **(e)(2)(ii)(M)**

Is personnel advised of potential hazards? **(e)(2)(ii)(M)**

Is personnel required to read instructions on practices and procedures, and required to follow them? **(e)(2)(ii)(M)**

Containment Equipment

Are certified biological safety cabinets (Class I, II, or III) or other appropriate combinations of personal protection or physical containment devices, such as special protective clothing, respirators, centrifuge safety cups, sealed centrifuge rotors, and containment caging for animals, used for all activities with other potentially infectious materials that pose a threat of exposure to droplets, splashes, spills, or aerosols? **(e)(2)(iii)(A)**

Are biological safety cabinets certified when installed, whenever they are moved and at least annually? **(e)(2)(iii)(B)**

Do the HIV and HBV research laboratories meet the following criteria?: **(e)(3)**

Does each laboratory contain a facility for hand washing and an eye wash facility that is readily available within the work area? **(e)(3)(i)**

	YES	NO
Is an autoclave for decontamination of regulated waste available? (e)(3)(ii)		
Do the HIV and HBV production facilities meet the following criteria?: (e)(4)		
Are work areas separated from areas that are open to unrestricted traffic flow within the building? (e)(4)(i)		
Is passage through two sets of doors the basic requirement for entry into the work area from access corridors or other contiguous areas? (e)(4)(i)		
Physical separation of the high-containment work area from access corridors or other areas or activities may also be provided by a double-doored clothes-change room (showers may be included), airlock, or other access facility that requires passing through two sets of doors before entering the work area. (e)(4)(i)		
Are the surfaces of doors, walls, floor, and ceilings in the work area water resistant so that they can be easily cleaned? (e)(4)(ii)		
Are penetrations in these surfaces sealed or capable of being sealed to facilitate decontamination? (e)(4)(ii)		
Does each work area contain a sink for washing hands and a readily available eye wash facility? (e)(4)(iii)		
Is the sink foot, elbow, or automatically operated? (e)(4)(iii)		
Is the sink located near the exit door of the work area? (e)(4)(iii)		
Are access doors to the work area or containment module self closing? (e)(4)(iv)		
Is an autoclave for decontamination of regulated waste available within or as near as possible to the work area? (e)(4)(v)		
Is a ducted exhaust-air ventilation system provided? (e)(4)(vi)		
Does this system create directional airflow that draws air into the work area through the entry area? (e)(4)(vi)		
Is the exhaust air not recirculated to any other area of the building? (e)(4)(vi)		
Is the exhaust air discharged to the outside and dispersed away from occupied areas and air intakes? (e)(4)(vi)		
Is the proper direction of the airflow verified (i.e., into the work area)? (e)(4)(vi)		
Training Requirements		
Additional training requirements for employees in HIV and HBV research laboratories and HIV and HBV production facilities are specified in paragraph (g)(2)(ix). (e)(5)		
(f) Hepatitis B Vaccination and Post-Exposure Evaluation and Follow-up		
General		
Does the employer make available the hepatitis B vaccine and vaccination series to all employees who have occupational exposure, and post-exposure evaluation and follow-up to all employees who have had an exposure incident? (f)(1)(i)		

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	YES	NO
Does the employer ensure that all medical evaluations and procedures including the hepatitis B vaccine and vaccination series and post-exposure evaluation and follow-up, including prophylaxis, are:		
• Made available at no cost to the employee, (f)(1)(ii)(A)		
• Made available to the employee at a reasonable time and place; (f)(1)(ii)(B)		
• Performed by or under the supervision of a licensed physician or by or under the supervision of another licensed healthcare professional; (f)(1)(ii)(C)		
AND		
• Provided according to recommendations of the U.S. Public Health Service current at the time these evaluations and procedures take place, except as specified by this paragraph (f)? (f)(1)(ii)(D)		
Does the employer ensure that all laboratory tests are conducted by an accredited laboratory at no cost to the employee? (f)(1)(iii)		
Hepatitis B Vaccination		
Is the hepatitis B vaccination made available after the employee has received the training required in paragraph (g)(2)(vii)(I) and within 10 working days of initial assignment to all employees who have occupational exposure unless the employee has previously received the complete hepatitis B vaccination series, antibody testing has revealed that the employee is immune, or the vaccine is contraindicated for medical reasons? (f)(2)(i)		
The employer cannot make participation in a prescreening program a prerequisite for receiving hepatitis B vaccination (f)(2)(ii)		
If the employee initially declines hepatitis B vaccination but at a later date while still covered under the standard decides to accept the vaccination, does the employer make available the hepatitis B vaccination at that time? (f)(2)(iii)		
Does the employer assure that employees who decline to accept hepatitis B vaccination offered by the employer sign the statement in Appendix A? (f)(2)(iv)		
If a routine booster dose(s) of hepatitis B vaccine is recommended by the U.S. Public Health Service at a future date, is such booster dose(s) made available in accordance with section (f)(1)(ii)? (f)(2)(v)		
Post-Exposure Evaluation and Follow-up		
Following a report of an exposure incident, does the employer make immediately available to the exposed employee a confidential medical evaluation and follow-up including at least the following elements: (f)(3)		
• Documentation of the route(s) of exposure and the circumstances under which the exposure incident occurred; (f)(3)(i)		
AND		
• Identification and documentation of the source individual, unless the employer can establish that identification is infeasible or prohibited by state or local law? (f)(3)(ii)		

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	YES	NO
Is the source individual's blood tested as soon as feasible and after consent is obtained in order to determine HBV and HIV infectivity? **(f)(3)(ii)(A)**		
If consent is not obtained, has the employer established that legally required consent cannot be obtained? **(f)(3)(ii)(A)**		
When the source individual's consent is not required by law, is the source individual's blood, if available, tested and the results documented? **(f)(3)(ii)(A)**		
When the source individual is already known to be infected with HBV or HIV, testing for the source individual's known HBV or HIV status need not be repeated. **(f)(3)(ii)(B)**		
Are results of the source individual's testing made available to the exposed employee? **(f)(3)(ii)(C)**		
Is the employee informed of applicable laws and regulations concerning disclosure of the identity and infectious status of the source individual? **(f)(3)(ii)(C)**		
Collection and Testing of Blood for HBV and HIV Serological Status		
Is the exposed employee's blood collected as soon as feasible and tested after consent is obtained? **(f)(3)(iii)(A)**		
If the employee consents to baseline blood collection, but does not give consent at that time for HIV serologic testing, is the sample preserved for at least 90 days? **(f)(3)(iii)(B)**		
If, within 90 days of the exposure incident, the employee elects to have the baseline sample tested, is such testing done as soon as feasible? **(f)(3)(iii)(B)**		
Post-exposure prophylaxis, when medically indicated, as recommended by the U.S. Public Health Service; Counseling; and Evaluation of reported illnesses. **(f)(3)(iv-vi)**		
Information Provided to the Healthcare Professional		
Does the employer ensure that the healthcare professional responsible for the employee's hepatitis B vaccination is provided a copy of this regulation? **(f)(4)(i)**		
Does the employer ensure that the healthcare professional evaluating an employee after an exposure incident is provided the following information:		
• A copy of this regulation; **(f)(4)(ii)(A)**		
• A description of the exposed employee's duties as they relate to the exposure incident; **(f)(4)(ii)(B)**		
• Documentation of the route(s) of exposure and circumstances under which exposure occurred; **(f)(4)(ii)(C)**		
• Results of the source individual's blood testing, if available; **(f)(4)(ii)(D)**		
AND		
• All medical records relevant to the appropriate treatment of the employee including vaccination status which are the employer's responsibility to maintain. **(f)(4)(ii)(E)**		

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	YES	NO
Healthcare Professional's Written Opinion		
Does the employer obtain and provide the employee with a copy of the evaluating healthcare professional's written opinion within 15 days of the completion of the evaluation? **(f)(5)**		
Is the healthcare professional's written opinion for hepatitis B vaccination limited to whether hepatitis B vaccination is indicated for an employee, and if the employee has received such vaccination? **(f)(5)(i)**		
Is the healthcare professional's written opinion for post-exposure evaluation and follow-up limited to the following information:		
• That the employee has been informed of the results of the evaluation **(f)(5)(ii)(A)**		
AND		
• That the employee has been told about any medical conditions resulting from exposure to blood or other potentially infectious materials which require further evaluation or treatment? **(f)(5)(ii)(B)**		
Are all other findings or diagnoses confidential and not included in the written report? **(f)(5)(iii)**		
Medical Recordkeeping		
Are medical records required by this standard maintained in accordance with paragraph (h)(1) of this section? **(f)(6)**		
(g) Communication of Hazards to Employees		
Labels and signs		
Labels		
Are warning labels affixed to containers of regulated waste, refrigerators and freezers containing blood or other potentially infectious material; and other containers used to store, transport or ship blood or other potentially infectious materials, except as provided in paragraph (g)(1)(i)(E),(F) and (G)? **(g)(1)(i)(A)**		
Do labels required by this section include the following legend?: **(g)(1)(i)(B)**		

BIOHAZARD

	YES	NO
Are these labels fluorescent orange or orange-red or predominantly so, with lettering or symbols in a contrasting color? **(g)(1)(i)(C)**		
Are required labels affixed as close as feasible to the container by string, wire, adhesive or other method that prevents their loss or unintentional removal? **(g)(1)(i)(D)**		

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YES	NO

Red bags or red containers may be substituted for labels. (g)(1)(i)(E)

Containers of blood, blood components, or blood products that are labeled as to their contents and have been released for transfusion or other clinical use are exempted from the labeling requirements of paragraph (g). (g)(1)(i)(F)

Individual containers of blood or other potentially infectious materials that are placed in a labeled container during storage, transport, shipment or disposal are exempted from the labeling requirement. (g)(1)(i)(G)

Are labels required for contaminated equipment in accordance with this paragraph? (g)(1)(i)(H)

Do labels required for contaminated equipment state which portions of the equipment remain contaminated? (g)(1)(i)(H)

Regulated waste that has been decontaminated need not be labeled or color-coded. (g)(1)(i)(I)

Signs

Does the employer post signs at the entrance to work areas specified in paragraph (e), HIV and HBV Research Laboratory and Production Facilities, which bear the following legend?: (g)(1)(ii)(A)

BIOHAZARD

(Name of the Infectious Agent)

(Special requirements for entering the area)

(Name, telephone number of the laboratory director or other responsible person.)

Are these signs fluorescent orange-red or predominantly so, with lettering or symbols in a contrasting color? (g)(1)(ii)(B)

Information and Training

Do employers ensure that all employees with occupational exposure participate in a training program which must be provided at no cost to the employee and during working hours? (g)(2)(i)

Is training provided as follows:

- At the time of initial assignment to tasks where occupational exposure may take place;
- Within 90 days after the effective date of the standard;

AND

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YES	NO

- At least annually thereafter? (g)(2)(ii)

For employees who have received training on bloodborne pathogens in the year preceding the effective date of the standard, is training provided only with respect to the provisions of the standard which were not included? (g)(2)(iii)

Is annual training for all employees provided within one year of their previous training? (g)(2)(iv)

Do employers provide additional training when changes such as modification of tasks or procedures or institution of new tasks or procedures affect the employee's occupational exposure? (g)(2)(v)

This additional training may be limited to addressing the new exposures created. (g)(2)(v)

Is the training material appropriate in content and vocabulary to educational level, literacy and language of employees? (g)(2)(vi)

Does the training program contain at a minimum the following elements:

- An accessible copy of the regulatory text of this standard and an explanation of its contents?; (g)(2)(vii)(A)
- A general explanation of the epidemiology and symptoms of bloodborne diseases?; (g)(2)(vii)(B)
- An explanation of the modes of transmission of bloodborne pathogens?; (g)(2)(vii)(C)
- An explanation of the employer's exposure control plan and the means by which the employee can obtain a copy of the written plan?; (g)(2)(vii)(D)
- An explanation of the appropriate methods for recognizing tasks and other activities that may involve exposure to blood and other potentially infectious materials?; (g)(2)(vii)(E)
- An explanation of the use and limitations of methods that will prevent or reduce exposure including appropriate engineering controls, work practices, and personal protective equipment?; (g)(2)(vii)(F)
- Information on the types, proper use, location, removal, handling, decontamination and disposal of personal protective equipment?; (g)(2)(vii)(G)
- An explanation of the basis for selection of personal protective equipment?; (g)(2)(vii)(H)
- Information on the hepatitis B vaccine, including information on its efficacy, safety, method of administration, the benefits of being vaccinated, and that the vaccine and vaccination will be offered free of charge?; (g)(2)(vii)(I)
- Information on the appropriate actions to take and persons to contact in an emergency involving blood or other potentially infectious materials?; (g)(2)(vii)(J)
- An explanation of the procedure to follow if an exposure incident occurs, including the method of reporting the incident and the medical follow-up that will be made available?; (g)(2)(vii)(K)
- Information on the post-exposure evaluation and follow-up that the employer is required to provide for the employee following an exposure incident?; (g)(2)(vii)(L)

	YES	NO

- An explanation of the signs and labels and/or color coding required by paragraph (g)(1)?; **(g)(2)(vii)(M)**

AND

- An opportunity for interactive questions and answers with the person conducting the training session? **(g)(2)(vii)(N)**

Is the person conducting the training knowledgeable in the subject matter covered by the elements contained in the training program as it relates to the workplace that the training will address? **(g)(2)(viii)**

Additional Initial Training for Employees in HIV and HBV Laboratories and Production Facilities

Have employees in HIV or HBV research laboratories and HIV or HBV production facilities received the following initial training in addition to the above training requirements?: **(g)(2)(ix)**

- Does the employer assure that employees demonstrate proficiency in standard microbiological practices and techniques and in the practices and operations specific to the facility before being allowed to work with HIV or HBV? **(g)(2)(ix)(A)**
- Does the employer assure that employees have prior experience in the handling of human pathogens or tissue cultures before working with HIV or HBV? **(g)(2)(ix)(B)**
- Does the employer provide a training program to employees who have no prior experience in handling human pathogens? **(g)(2)(ix)(C)**
- Do initial work activities not include the handling of infectious agents? **(g)(2)(ix)(C)**
- Is a progression of work activities assigned as techniques are learned and proficiency is developed? **(g)(2)(ix)(C)**
- Does the employer assure that employees participate in work activities involving infectious agents only after proficiency has been demonstrated? **(g)(2)(ix)(C)**

(h) Recordkeeping

Medical Records

Does the employer establish and maintain an accurate record for each employee with occupational exposure, in accordance with 29 CFR 1910.20? **(h)(1)(i)**

Does this record include:

- The name and social security number of the employee; **(h)(1)(ii)(A)**
- A copy of the employee's hepatitis B vaccination status including the dates of all the hepatitis B vaccinations and any medical records relative to the employee's ability to receive vaccination as required by paragraph (f)(2) **(h)(1)(ii)(B)**
- A copy of all results of examinations, medical testing, and follow-up procedures as required by paragraph (f)(3); **(h)(1)(ii)(C)**
- The employer's copy of the healthcare professional's written opinion as required by paragraph (f)(5); **(h)(1)(ii)(D)**

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	YES	NO

AND

- A copy of the information provided to the healthcare professional as required by paragraphs (f)(4)(ii)(B)(C) and (D)? **(h)(1)(ii)(E)**

Confidentiality

Does the employer ensure that employee medical records required by paragraph (h)(1) are:

- Kept confidential; **(h)(1)(iii)(A)**

AND

- Are not disclosed or reported without the employee's express written consent to any person within or outside the workplace except as required by this section or as may be required by law? **(h)(1)(iii)(B)**

Does the employer maintain the records required by paragraph (h) for at least the duration of employment plus 30 years in accordance with 29 CFR 1910.20? **(h)(1)(iv)**

Training Records

Do training records include the following information:

- The dates of the training sessions; **(h)(2)(i)(A)**
- The contents or a summary of the training sessions; **(h)(2)(i)(B)**
- The names and qualifications of persons conducting the training; **(h)(2)(i)(C)**

AND

- The names and job titles of all persons attending the training sessions? **(h)(2)(i)(D)**

Are training records maintained for 3 years from the date on which the training occurred? **(h)(2)(ii)**

Availability

Does the employer ensure that all records required to be maintained by this section are made available upon request to the Assistant Secretary and the Director for examination and copying? **(h)(3)(i)**

Are employee training records required by this paragraph provided upon request for examination and copying to employees, to employee representatives, to the Director and to the Assistant Secretary in accordance with 29 CFR 1910.20? **(h)(3)(ii)**

Are employee medical records required by this paragraph provided upon request for examination and copying to the subject employee, to anyone having written consent of the subject employee, to the Director and to the Assistant Secretary in accordance with 29 CFR 1910.20? **(h)(3)(iii)**

Transfer of Records

Does the employer comply with the requirements involving transfer of records set forth in 29 CFR 1910.20(h)? **(h)(4)(i)**

If the employer ceases to do business and there is no successor employer to receive and retain the records for the prescribed period, has the employer notified the Director, at least three months prior to their disposal and transmitted them to the Director, if required by the Director to do so, within that three month period? **(h)(4)(ii)**

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	YES	NO
(i) Dates		
Effective Date		
The standard becomes effective on March 6, 1992. **(i)(1)**		
The Exposure Control Plan required by paragraph (c)(2) of this section must be completed on or before May 5, 1992. **(i)(2)**		
Paragraphs (g)(2) Information and Training and (h) Recordkeeping take effect on or before June 4, 1992. **(i)(3)**		
Paragraphs (d)(2) Engineering and Work Practice Controls,(d)(3) Personal Protective Equipment, (d)(4) Housekeeping,(e) HIV and HBV Research Laboratories and Production Facilities,(f) Hepatitis B Vaccination and Post-Exposure Evaluation and Follow-up, and (g)(1) Labels and Signs, take effect July 6, 1992. **(i)(4)**		

YES	NO

NOTE:

Pages Z-43 through Z-46 are reserved for Standards 1910.1031 through 11910.1042, which have not yet been made.

1910.1043 — COTTON DUST

(a) Scope and Application. **(a)**

This standard applies to the control of employee exposure to cotton dust in all workplaces where employees engage in yarn manufacturing, slashing and weaving operations, or work in waste houses for textile operations. **(a)(1)**

This standard does not cover the handling or processing of woven or knitted material, to maritime operations (covered by parts 1915 and 1918), to cotton harvesting or ginning, or to the construction industry. **(a)(2)**

Where employees engaged in cottonseed processing or waste processing operations are exposed to cotton dust, only paragraphs (h) Medical surveillance, (k)(2) - (4) Recordkeeping — medical records, and Appendices B, C, and D of this standard apply. **(a)(3)**

For yarn manufacturing and slashing and weaving operations exclusively using washed cotton, see paragraph (n) of this standard. **(a)(4)**

This standard covers all employee exposure to cotton dust generated in the preparation of washed cotton — from opening until the cotton is thoroughly wetted. **(a)(5)**

This standard exempts knitting, classing, and warehouse operations except when NIOSH requests to perform health study sampling. **(a)(6)**

(b) Definitions **(b)**

"Assistant Secretary" — the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee.

"Blow down" — the general cleaning of a room or a part of a room by the use of compressed air.

"Blow off" — the use of compressed air for cleaning of short duration and usually for a specific machine or any portion of a machine.

"Cotton dust" — dust present in the air during the handling or processing of cotton, which may contain a mixture of many substances including ground up plant matter, fiber, bacteria, fungi, soil, pesticides, non-cotton plant matter and other contaminants which may have accumulated with the cotton during the growing, harvesting and subsequent processing or storage periods. Any dust present during the handling and processing of cotton through the weaving or knitting of fabrics, and dust present in other operations or manufacturing processes using raw or waste cotton fibers or cotton fiber byproducts from textile mills are considered cotton dust within this definition. Lubricating oil mist associated with weaving operations is not considered cotton dust.

"Director" — the Director of the National Institute for Occupational Safety and Health (NIOSH), U.S. Department of Health and Human Services, or designee.

"Equivalent instrument." — a cotton dust sampling device that meets the vertical elutriator equivalency requirements as described in paragraph (d) (1) (iii) of this section.

YES	NO

"Lint-free respirable cotton dust" — particles of cotton dust of approximately 15 micrometers or less aerodynamic equivalent diameter.

"Vertical elutriator cotton dust sampler" or "vertical elutriator" — a dust sampler which has a particle size cut-off at approximately 15 micrometers aerodynamic equivalent diameter when operating at the flow rate of 7.4 ± 0.2 liters of air per minute.

"Waste processing" — waste recycling (sorting, blending, cleaning and willowing) and garnetting.

"Yarn manufacturing" — all textile mill operations from opening to, but not including, slashing and weaving.

(c) Permissible Exposure Limits and Action Levels. **(c)**

Are precautions taken to assure that no employee who is exposed to cotton dust in yarn manufacturing and cotton washing is exposed to airborne concentrations of lint-free respirable cotton dust greater than 200μg/m^3 (micrograms per cubic meter of air) mean concentration, averaged over an 8-hour period, as measured by a vertical elutriator or an equivalent instrument. **(c)(1)(i)**

Are precautions taken to assure that no employee who is exposed to cotton dust in textile mill waste house operations or, in yarn manufacturing, to dust from "lower grade washed cotton," is exposed to airborne concentrations of lint-free respirable cotton dust greater than 500μg/m^3 mean concentration averaged over an 8-hour period? **(c)(1)(ii)**

Are precautions taken to assure that no employee who is exposed cotton dust in the textile process known as slashing and weaving is exposed to airborne concentrations of lint-free respirable cotton dust greater than 750μg/m^3 mean concentration, averaged over an 8-hour period? **(c)(1)(iii)**

The action level for yarn manufacturing and cotton washing operations is an airborne concentration of lint-free respirable cotton dust of 100μg/m^3 mean concentration averaged over an 8-hour period as measured by a vertical elutriator or equivalent instrument. **(c)(2)(i)**

The action level for waste houses for textile operations is an airborne concentration of lint-free respirable cotton dust of 250μg/m^3 mean concentration averaged over an 8-hour period. **(c)(2)(ii)**

The action level for the textile processes of slashing and weaving is an airborne concentration of lint-free respirable cotton dust of 375μg/m^3 mean concentration averaged over an 8-hour period. **(c)(2)(iii)**

Are precautions taken to assure that no employee who is exposed to cotton dust [except exposures covered by (c)(1) and (2) above] is exposed to airborne concentrations of lint-free respirable cotton dust greater than 500μg/m^3 mean concentration averaged over an 8-hour period, measured as in (c)(1) above? **(c)(3)**

YES	NO

	YES	NO
(d) Exposure Monitoring and Measurement. **(d)**		
NOTE: For the purpose of this section, employee exposure is that exposure which would occur if the employee were not using a respirator. **(d)(1)(i)**		
Is the sampling device used either the vertical elutriator cotton dust sampler or an equivalent instrument? **(d)(1)(ii)**		
If an alternative to the vertical elutriator is used, has equivalency been established by demonstrating that the alternative sampling device does the following: **(d)(1)(iii)**		
Collects respirable particulates in the same range as the vertical elutriator (approximately 15 microns)? **(d)(1)(iii)(A)**		
Replicates exposure data in side-by-side field and laboratory comparisons? **(d)(1)(iii)(B)**		
Is equivalent within an accuracy and precision range of plus or minus 25% for 95% of the samples, over the range of 0.5 to 2 times the permissible exposure limit with at least 100 samples taken? **(d)(1)(iii)(C)**		
OSHA will provide a written statement that an instrument is equivalent to a vertical elutriator cotton dust sample if: **(d)(1)(iv)**		
The employer requests the statement and supplies the following information: **(d)(1)(iv)(A)**		
Test data demonstrating that the instrument meets the requirements of this paragraph and Appendix E.		
Any other relevant information requested by OSHA.		
A certification from the manufacturer or employer that the information supplied is accurate.		
OSHA finds that the instrument meets the requirements for equivalency. **(d)(1)(iv)(B)**		
Has initial monitoring been conducted to determine the airborne concentrations of lint-free respirable cotton dust which are representative of the exposure of all employees over an 8-hour period? **(d)(2)**		
Does the sampling program include at least one determination during each shift for each work area? **(d)(2)**		
Are the measurements required by (d)(2) above repeated at least annually if at or below the permissible exposure limit? **(d)(3)(i)**		
Are the measurements required by (d)(2) above repeated at least every six months if above the permissible exposure limit? **(d)(3)(ii)**		
Is monitoring and measurement repeated whenever there has been a production, process, or control change which may result in new or additional exposures to cotton dust, or whenever the employer has any other reason to suspect an increase in employee exposure. **(d)(3)(iii)**		

	YES	NO
Is each employee notified in writing, within 20 working days after receipt of the monitoring results, of the measurements which represent that employee's exposure? **(d)(4)(i)**		
Whenever the permissible exposure limit is exceeded, does the written notification include a statement that the permissible limit was exceeded, and describing the corrective actions being taken to reduce exposure to or below the permissible exposure limit? **(d)(4)(ii)**		
(e) Methods of Compliance **(e)**		
Are feasible engineering and work practice controls instituted to reduce and maintain employee exposures at or below the permissible exposure limit? **(e)(1)**		
Where such feasible engineering and work practice controls are not sufficient to reduce employee exposures to or below the permissible limits, are they nonetheless used to reduce exposures to the lowest level achievable, and then supplemented with the use of respirators which comply with the provision of (f) below? **(e)(2)**		
When employees are exposed above the permissible exposure limit, is a written program established and implemented to reduce employee exposures to or below the permissible limit solely by means of engineering controls and work practices as required by (e)(1) above? **(e)(3)(i)**		
Does the written program include at least the following: **(e)(3)(ii)**		
A description of each operation or process resulting in excessive employee exposure to cotton dust? **(e)(3)(ii)(A)**		
Engineering plans and other studies used to determine the controls for each process? **(e)(3)(ii)(B)**		
A report of the technology considered in meeting the permissible exposure limit? **(e)(3)(ii)(C)**		
Monitoring data obtained in accordance with (d) above? **(e)(3)(ii)(D)**		
A detailed schedule for development and implementation of engineering and work practice controls, including exposure levels projected to be achieved by such controls? **(e)(3)(ii)(E)**		
Work practice program? **(e)(3)(ii)(F)**		
Other relevant information? **(e)(3)(ii)(G)**		
Does the written program project completion of the compliance program no later than March 27, 1984? **(e)(3)(iii)**		
Are the steps set forth in the compliance program completed by the dates in the schedule? **(e)(3)(iv)**		
Is the written program available at the worksite for examination and copying by the Assistant Secretary of Labor, the Director of NIOSH, and any affected employee or their designated representative? **(e)(3)(v)**		
Is the written program revised and updated when necessary to reflect the current status of the program and current exposure levels? **(e)(3)(vi)**		

When mechanical ventilation is used to control exposure, are measurements which demonstrate the effectiveness of the system to control exposure, such as capture velocity, duct velocity, or static pressure made at reasonable intervals? **(e)(4)**

(f) Use of Respirators. **(f)**

Is an appropriate respirator provided at no cost to the employee and its use assured in the following circumstances: **(f)(1)**

During the time periods necessary to install or implement feasible engineering controls and work practice controls? **(f)(1)(i)**

During maintenance and repair activities in which engineering and work practice controls are not feasible? **(f)(1)(ii)**

In work situations where feasible engineering and work practice controls are not yet sufficient to reduce exposure to or below the permissible exposure limit? **(f)(1)(iii)**

In operations specified under paragraph (g) (1) below (blow downs)? **(f) (1) (iv)**

Whenever an employee requests a respirator? **(f)(1)(v)**

Where respirators are required, is an appropriate respirator selected based on the following concentrations? **(f)(2)(i)**

TABLE I

Cotton Dust Concentration	Required Respirator
Not greater than:	
(a) 5 x the applicable permissible exposure limit (PEL).	A disposable respirator with a particulate filter.
(b) 10 x the applicable PEL.	A quarter or half-mask respirator, other than a disposable respirator, equipped with particulate filters.
(c) 100 x the applicable PEL.	A full facepiece respirator equipped with high-efficiency particulate filters.
(d) Greater than 100 x the applicable PEL.	A powered air-purifying respirator equipped with high efficiency particulate filters.

NOTES

1. A disposable respirator means the filter element is an inseparable part of the respirator.
2. Any respirators permitted at higher environmental concentrations can be used at lower concentrations.
3. Self-contained breathing apparatus are not required respirators but are permitted respirators.
4. Supplied air respirators are not required but are permitted under the following conditions: Cotton dust concentration not greater than 10X the PEL — Any supplied air respirator; not greater than 100X the PEL — Any supplied air respirator with full facepiece, helmet or hood; greater than 100X the PEL — A supplied air respirator operated in positive pressure mode.

Are respirators selected from among those approved by the National Institute for Occupational Safety and Health (NIOSH) under the provisions of 30 CFR Part 11? **(f)(2)(ii)**

Is a powered air purifying respirator with a high efficiency particulate filter provided, upon request of an employee, for use in concentrations not greater than 100 times the PEL? **(f)(2)(iii)**

When an employee is found physically unable to wear any respirator, is he/she given the option of transfer to another available position that has a dust level at or below the PEL, with no loss of earnings or other employment rights or benefits? **(f)(2)(iv)**

Does the respirator program meet the requirements of 1910.134(b), (d), (e) and (f)? **(f)(3)**

Do the respirators used by employees exhibit minimum facepiece leakage and are they properly fitted? **(f)(4)(i)**

Is each employee who uses a filter respirator allowed to change the filter elements whenever an increase in breathing resistance is detected by the employee? **(f)(4)(ii)**

Is an adequate supply of filter elements maintained for this purpose? **(f)(4)(ii)**

Are employees who wear respirators allowed to wash their face and respirator facepiece to prevent skin irritation associated with respirator use? **(f)(4)(iii)**

(g) Work Practices. **(g)**

Regardless of the level of employee exposure, has a written program of work practices been established and implemented to minimize cotton dust exposure for each specific job? **(g)**

Have the following work practices been included in the work practices program, where applicable? **(g)**

Compressed air "blow down" cleaning is prohibited, where alternative means are feasible. Where compressed air "blow down" is done, respirators are worn by the employees performing the "blow down" and employees in the area whose presence is not required to perform the "blow down" are required to leave the area during the cleaning operation. **(g)(1)**

Cleaning of clothing or floors with compressed air is prohibited. **(g)(2)**

Floor sweeping is performed with a vacuum or with methods designed to minimize dispersal of dust. **(g)(3)**

Cotton and cotton waste is stacked, sorted, baled, dumped, removed or otherwise handled by mechanical means, except where the employer can show that it is infeasible to do so. Where infeasible, the method used for handling cotton and cotton waste shall be the method which reduces exposure to the lowest level feasible. **(g)(4)**

(h) Medical Surveillance. **(h)**

Has a program of medical surveillance been instituted for all employees exposed to cotton dust? **(h)(1)(i)**

	YES	NO
Are all medical examinations and procedures performed by or under the supervision of a licensed physician, and provided without cost to the employee? **(h)(1)(ii)**		
Have persons other than licensed physicians, who administer the pulmonary function testing required by this section, completed by NIOSH-approved training course in spirometry? **(h)(1)(iii)**		
Is each employee who is or may be exposed to cotton dust provided with an opportunity for medical surveillance to include at least the following: *NOTE: For new employees this examination shall be provided prior to initial assignment.* **(h)(2)**		
A medical history? **(h)(2)(i)**		
The standardized questionnaire contained in Appendix Z-H*? **(h)(2)(ii)**		
A pulmonary function measurement, including a determination of forced vital capacity (FVC) and forced expiratory volume in 1 second (FEV_1), and the percentage that the measured values of FEV and FVC differ from the predicted values, using the standard tables in Appendix Z-I*? **(h)(2)(iii)**		
NOTE: These determinations shall be made for each employee before the employee enters the workplace on the first day of the work week, following at least 35 hours after previous exposure to cotton dust. The tests shall be repeated during the shift, no sooner than four and no more than ten hours after the beginning of the work shift; and, in any event, no more than one hour after cessation of exposure. **(h)(2)(iii)**		
Based upon the questionnaire results, shall each employee be graded according to Schilling's byssinosis classification system? **(h)(2)(iv)**		
Is annual medical surveillance provided for all employees exposed to cotton dust above the action level in yarn manufacturing, slashing and weaving, cotton washing, and waste house operations? **(h)(3)(i)**		
Is medical surveillance provided at least every two years for all employees exposed to cotton dust at or below the action level, for all employees exposed to cotton dust from washed cotton [except as in paragraph (n)(3)] and for employees exposed to cotton dust in cottonseed processing and waste processing operations. **(h)(3)(i)**		
Does periodic medical surveillance include at least an update of the medical history, standardized questionnaire, Schilling byssinosis grade, and the pulmonary function measurements? **(h)(3)(i)**		
Is medical surveillance, as prescribed in (h)(3)(i) above, provided every six months for employees in the following categories? **(h)(3)(ii)**		
An FEV_1 of greater than 80% of the predicted value, but with an FEV_1 decrement of 5%, or 200 ml, on a first working day. **(h)(3)(ii)(A)**		
An FEV_1 of less than 80% of the predicted value. **(h)(3)(ii)(B)**		
Where, in the opinion of the physician, any significant change in questionnaire findings, pulmonary function results, or other diagnostic tests has occurred. **(h)(3)(ii)(C)**		

	YES	NO
Is an employee whose FEV_1 is less than 60% of the predicted value referred to a physician for a detailed pulmonary examination? **(h)(3)(iii)**		
Is a comparison made between the current examination results and those of previous examinations, and a determination made by the physician as to whether there has been a significant change? **(h)(3)(iv)**		
Is the following information provided to the examining physician: **(h)(4)**		
A copy of this regulation and its appendices? **(h)(4)(i)**		
A description of the affected employee's duties as they relate to the employee's exposure? **(h)(4)(ii)**		
The employee's exposure level or anticipated exposure level? **(h)(4)(iii)**		
A description of any personal protective equipment used or to be used? **(h)(4)(iv)**		
Information from previous medical examinations of the affected employee which is not readily available to the examining physician? **(h)(4)(v)**		
Has the employee been provided with a copy of the examining physician's written opinion containing the following? **(h)(5)(i)**		
The results of the medical examination and tests. **(h)(5)(i)(A)**		
The physician's opinion as to whether the employee has any detected medical conditions which would place the employee at increased risk of material impairment of the employee's health from exposure to cotton dust. **(h)(5)(i)(B)**		
The physician's recommended limitations upon the employee's exposure to cotton dust or upon the employee's use of respirators, including a determination of whether an employee can wear a negative pressure respirator; and if he cannot, a determination of the employee's ability to wear a powered air purifying respirator. **(h)(5)(i)(C)**		
A statement that the employee has been informed by the physician of the results of the medical examination and any medical conditions which require further examination or treatment. **(h)(5)(i)(D)**		
NOTE: The written opinion obtained by the employer shall not reveal specific findings or diagnoses unrelated to occupational exposure. **(h)(5)(ii)**		
(i) Employee Education and Training. **(i)**		
Is a training program provided for all employees in all workplaces where cotton dust is present, and is each employee informed of the following? **(i)(1)(i)**		
The acute and long term health hazards associated with exposure to cotton dust. **(i)(1)(i)(A)**		
The specific nature of the operations which could result in exposure to cotton dust at or above the permissible exposure limit (PEL). **(i)(1)(i)(B)**		
The measures, including work practices required by (g) above, necessary to protect the employee from exposures in excess of the PEL. **(i)(1)(i)(C)**		

	YES	NO
The purpose, proper use and limitations of respirators required by (f) above. (i)(1)(i)(D)		
The purpose for and a description of the medical surveillance program required by (h) above, and other information which will aid exposed employees in understanding the hazards of cotton dust exposure. (i)(1)(i)(E)		
The contents of this standard and its appendices. (i)(1)(i)(F)		
Is the training program provided prior to initial assignment and repeated annually for each employee exposed to cotton dust, when job assignments or work processes change, and when employee performance indicates a need for retraining? (i)(1)(ii)		
Is a copy of this standard and its appendices posted in a public location at the workplace, and are copies available to employees upon request? (i)(2)(i)		
Are all materials relating to the employee training and information program provided upon request to the Assistant Secretary of Labor and the Director of NIOSH? (i)(2)(ii)		
(j) Signs. (j)		
Is the following warning sign posted in each work area where the permissible exposure limit for cotton dust is exceeded? (j)		
WARNING COTTON DUST WORK AREA May Cause Acute or Delayed Lung Injury (Byssinosis) RESPIRATORS REQUIRED IN THIS AREA		
(k) Recordkeeping. (k)		
Is an accurate record established and maintained of all measurements required by (d) above? (k)(1)(i)		
Does the record include: (k)(1)(ii)		
A log containing the items listed in paragraph IV (a) of Appendix Z-G*, and the dates, number, duration, and results of each of the samples taken, including a description of the procedure used to determine representative employee exposures? (k)(1)(ii)(A)		
The type of protectice devices worn, of any, and length of time worn? (k)(1)(ii)(B)		
Names, social security numbers, job classifications, and exposure levels of employees whose exposure the measurement is intended to represent? (k)(1)(ii)(C)		
Is the record maintained for at least 20 years? (k)(1)(iii)		
Is an accurate medical record established and maintained for each employee subject to medical surveillance required by (h) above? (k)(2)(i)		
Does the record include: (k)(2)(ii)		
The name and social security number and description of the duties of the employee? (k)(2)(ii)(A)		

	YES	NO
A copy of the medical examination results including the medical history, questionnaire responses, results of all tests, and the physician's recommendation? (k)(2)(ii)(B)		
A copy of the physician's written opinion? (k)(2)(ii)(C)		
Any employee medical complaints related to exposure to cotton dust? (k)(2)(ii)(D)		
A copy of this standard and its appendices, except that the employer may keep one copy of the standard and the appendices for all employees provided that he references the standard and appendices in the medical surveillance record of each employee? (k)(2)(ii)(E)		
A copy of the information provided to the physician as required by (h)(4) above? (k)(2)(ii)(F)		
Is the medical record maintained for at least 20 years? (k)(2)(iii)		
Are the records to be maintained by this section made available, upon request, for examination and copying by the Assistant Secretary of Labor and the Director of NIOSH? (k)(3)(i)		
Are employee exposure measurement records, required by this section, made available for examination and copying, to the affected employees or their designated representatives? (k)(3)(ii)		
Has the following been accomplished when an employer ceases to do business: (k)(4)		
The successor employer receives and retains all records required to be maintained by this section? (k)(4)(i)		
When there is no successor to receive and retain the records for the prescribed period, they are transmitted to the Director of NIOSH? (k)(4)(ii)		
Is the Director of NIOSH notified three months prior to disposal of required records which have met the mandatory retention period (20 years), and are such records transmitted to the Director if he requests them within the three-month period? (k)(4)(iii)		
The employer also must comply with any other requirements involving transfer of records as set forth in 29 CFR 1910.20(h). (k)(4)(iv)		
(l) Observation of Monitoring (l)		
Are affected employees, or their designated representatives, provided an opporunity to observe any required measuring or monitoring of employee exposure to cotton dust? (l)(1)		
Are observers provided necessary personal protective equipment, and is the use of such equipment and compliance with all other applicable safety and health procedures assured when entering areas where the use of personal protective equipment is required? (l)(2)		
Without interfering with the measurement, are observers entitled to:		
An explanation of the measurement procedures? (l)(2)(i)		

	YES	NO
An opportunity to observe all steps related to the measurement of airborne concentrations of cotton dust performed at the place of exposure? **(l)(2)(ii)**		
An opportunity to record the results obtained? **(l)(2)(iii)**		
(m) Effective Dates **(m)**		
This section is effective March 27, 1980, except as provided below: **(m)(1)**		
START UP DATES — AS SOON AS POSSIBLE, BUT NO LATER THAN:		
April 27, 1980 Respirators required by paragraph (f) are provided to employees.		
June 27, 1980 Work practices program required by paragraph (g) implemented. Completion of initial education and training required by paragraph (i).		
March 27, 1981 Completion of the compliance program required by paragragh (e)(3). Completion of medical surveillance required by paragraph (h) for textile industry.		
March 27, 1984 Completion of inital monitoring required by paragraph (d)(2). Completion of engineering and work practice controls as required by paragraph (e), except for ring spinning of coarse count yarn with high cotton content.		
February 13, 1986 Updating of compliance plan for ring spinning of coarse count yarn with high cotton content.		
March 27, 1986 Completion of engineering and work practice controls as required in paragraph (e) for ring spinning operations of coarse count yarn with high cotton content.		
June 13, 1986 Completion of medical surveillance required by paragraph (h) for cottonseed processing and waste processing industry. Total compliance by industry with the standard.		
(n) Washed Cotton **(n)**		
Cotton that has been washed by the processes described below is exempt from all or parts of this standard. **(n)(1)**		
Was the cotton washed in a facility which is open to inspection by the Assistant Secretary of Labor? **(n)(2)**		
Is there sufficient accurate documentary evidence to show that the washing methods meet the requirements of this section? **(n)(2)**		
If the cotton was washed in a facility not under the employer's control, is the following available at the worksite (to employees, designated representatives, and the Assistant Secretary): **(n)(2)(ii)**		

	YES	NO
A certification from the washer of the grade of the cotton, the type of washing process, and that the batch meets the requirements of this section? **(n)(2)(ii)(A)**		
Sufficient accurate documentation by the washer of the cotton grades and washing process? **(n)(2)(ii)(B)**		
An authorization from the washer that the Assistant Secretary of Labor or the Director of NIOSH may inspect the washer's facilities and documentation of the process? **(n)(2)(ii)(C)**		
Medical grade (USP) cotton, cotton that has been scoured, bleached, and dyed, and mercerized yarn is exempt from all provisions of this standard. **(n)(3)**		
Also exempt from coverage by this standard (except for (h) Medical Surveillance, (k)(2)-(4) Recordkeeping, and Appendices B, C, and D) is the handling or processing of cotton classes as "low middling light spotted or better" which has been washed: **(n)(4)**		
On a continuous batt system or a rayon rinse system. **(n)(4)(i)**		
With water. **(n)(4)(ii)**		
At a temperature of no less than 60 C. **(n)(4)(iii)**		
With a water-to-fiber ratio of noless than 40:1. **(n)(4)(iv)**		
With bacterial levels in the wash water controlled to limit bacterial contamination of the cotton. **(n)(4)(v)**		
The handling and processing of cotton of grades lower than "low middling light spotted" that has been washed as specified above and has also been bleached, is exempt from all the standard's requirements except the requirements of (c)(1)(ii) Permissible Exposure Limit, (d) Exposure Monitoring, (h) Medical Surveillance, (k) Recordkeeping, and Appendices B, C, and D. **(n)(5)**		
If more than one grade of washed cotton is being handled or processed together, are the requirements of the grade with the most stringent exposure limit, medical, and monitoring requirements followed? **(n)(6)**		
(o) Appendices **(o)**		
Appendices Z-H, Z-I and Z-J are incorporated as part of this section and the contents of these appendices are mandatory. **(o)(i)**		
Appendix Z-G contains information which is not intended to create any additional obligations not otherwise imposed or to detract from any existing obligations. **(o)(ii)**		
Appendix Z-Ja of this section is a protocol which may be followed in order to validate alternative cotton sampling devices as equivalent to the vertical elutriator cotton dust sampler. Other protocols may be used if they are statistically valid, meet the requirements of this section, and are appropriate for demonstrating equivalency. **(o)(3)**		

YES	NO

(Reserved for future use)

YES	NO

1910.1044 – 1,2-DIBROMO-3-CHLOROPROPANE (DBCP)

	YES	NO
The following permanent standard became effective April 17, 1978.		
(a) **Scope and Application.** (a)		
This section applies to occupational exposure to 1,2-dibromo-3-chloropropane (DBCP). (a)(1)		
This section does not apply to:		
Exposure to DBCP which results solely from application and use as a pesticide.		
Storage, transportation, distribution or sale of DBCP in intact containers sealed in such a manner as to prevent exposure to DBCP vapors or liquid. (Excepted are the requirements that apply to emergency situations, employee information and training, and signs and labels, all of which remain applicable and are contained in paragraphs (i), (n) and (o) of this section.) (a)(2)(ii)		
(c) **Permissible Exposure Limits.** (c)		
Is the occupational environment controlled so that no employee is exposed to an airborne concentration of DBCP in excess of 1 part per billion parts of air (ppb) as an 8-hour time-weighted average (TWA)? (c)(1)		
Are precautions taken to ensure that no employee is exposed to eye or skin contact with DBCP? (c)(2)		
Has the following information been reported to the OSHA Area Office within 10 days following the introduction of DBCP into the workplace: (d)		
The address and location of the workplace? (d)(1)		
A brief description of each process or operation which may result in employee exposure to DBCP? (d)(2)		
The number of employees engaged in each process or operation who may be exposed to DBCP and an estimate of the frequency and degree of exposure that occurs? (d)(3)		
A brief description of the employer's safety and health program as it relates to limitation of employee exposure to DBCP? (d)(4)		
(e) **Regulated Areas.** (e)		
Are regulated areas established wherever DBCP concentrations are in excess of the permissible exposure limit? (e)(1)		
Is access to regulated areas limited to authorized persons? (e)(2)		
NOTE: "Authorized person" means any person required by his duties to be present in regulated areas and authorized to do so by the employer, this section, or the Act. It includes designated representatives of employees exercising an opportunity to observe employee exposure monitoring.		
(f) **Exposure Monitoring.** (f)		
Have air samples been taken and measured to determine airborne exposure levels representative of each employee's exposure to DBCP over an 8-hour period? (f)(1)(i)		
NOTE: For the purposes of this paragraph, employee exposure is that exposure which would occur if the employee were not using a respirator. (f)(1)(ii)		
Has initial monitoring been conducted of each workplace and work operation to accurately determine the airborne concentrations of DBCP to which employees may be exposed? (f)(2)		

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	YES	NO
Is monitoring repeated at least quarterly when measurements reveal employee exposures to be below the permissible exposure limit (1ppb)? (f)(3)(i)		
Is monitoring repeated at least monthly for affected employees when measurements reveal exposure to be in excess of the permissible limit? (f)(3)(ii)		
Is such monthly monitoring continued until at least two consecutive measurements, taken at least seven days apart, are below the permissible exposure limit (quarterly thereafter)? (f)(3)(ii)		
Is monitoring repeated whenever there has been a production, process, control, or personnel change which may result in any new or additional exposure to DBCP or whenever the employer has reason to suspect new or additional exposures? (f)(4)		
Is each employee notified in writing, within 5 working days after receipt of the monitoring results, of the measurements which represent the employee's exposure? (f)(5)(i)		
Whenever the permissible exposure limit is exceeded, does the written notification include a statement that the permissible limit was exceeded, and the corrective actions being taken to reduce exposure to or below the permissible exposure limit? (f)(5)(ii)		
Does the method of measurement have an accuracy, to a confidence level of 95%, of not less than plus or minus 25% for concentrations of DBCP at or above the permissible limit (1 ppb)? (f)(6)		
(g) **Methods of Compliance.** (g)		
Are feasible engineering and work practice controls instituted to reduce and maintain employee exposures at or below the permissible exposure limit? (g)(1)		
Where such feasible engineering and work practice controls are not sufficient to reduce employee exposures to within the permissible limit, are they nonetheless used to reduce exposures to the lowest level achievable and then supplemented by use of respiratory protection? (g)(1)		
Is a written program established and implemented to reduce employee exposures to DBCP to or below the permissible exposure limit solely by means of engineering and work practice controls as required by (g)(1) above? (g)(2)(i)		
Does the written program include a detailed schedule for development and implementation of the engineering and work practice controls? (g)(2)(ii)		
Are these plans revised at least every six months to reflect the current status of the program? (g)(2)(ii)		
Are written plans for these compliance programs available at the worksite for examination and copying by the Assistant Secretary of Labor, the Director of NIOSH, and any affected employee or designated representative of employees? (g)(2)(iii)		
Are the controls described in the most recent written compliance program instituted and maintained? (g)(2)(iv)		
(h) **Respirators.** (h)		
Are employees provided with and required to wear respirators in the following circumstances: (h)(1)		
During the period necessary to install or implement feasible engineering and work practice controls? (h)(1)(i)		

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	YES	NO
During maintenance and repair activities in which engineering and work practice controls are not feasible? (h)(1)(ii)		
In work situations where feasible engineering and work practice controls are not yet sufficient to reduce exposure to or below the permissible exposure limit? (h)(1)(iii)		
In emergencies? (h)(1)(iv)		
When respirators are required, is an appropriate respirator selected based on the following concentrations or condition of use? (h)(2)(i)		

Airborne Concentration of DBCP or Condition of Use	Respirator Type
(a) Less than or equal to 10 ppb.	(1) Any supplied-air respirator; or (2) any self-contained breathing apparatus.
(b) Less than or equal to 50 ppb.	(1) Any supplied-air respirator with full facepiece, helmet, or hood; or (2) any self-contained breathing apparatus with full facepiece.
(c) Less than or equal to 1,000 ppb.	(1) A Type C supplied-air respirator operated in pressure-demand or other positive pressure or continuous flow mode.
(d) Less than or equal to 2,000 ppb.	(1) A Type C supplied-air respirator with full facepiece operated in pressure-demand or other positive pressure mode, or with full facepiece, helmet, or hood operated in continuous flow mode.
(e) Greater than 2,000 ppb or entry and escape from unknown concentrations.	(1) A combination respirator which includes a Type C supplied-air respirator with full facepiece operated in pressure-demand or other positive pressure or continuous flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or positive pressure mode; or (2) a self-contained breathing apparatus with full facepiece operated in pressure-demand or other positive pressure mode.
(f) Firefighting	(1) A self-contained breathing apparatus with full facepiece operated in pressure-demand or other positive pressure mode.

	YES	NO
Are respirators provided at no cost to the employees and their use assured when conditions so require? (h)(2)(i)		
Are respirators selected from among those approved by the National Institute for Occupational Safety and Health (NIOSH) under the provisions of 30 CFR Part 11? (h)(2)(ii)		
Does the respiratory protection program meet the requirements of 1910.134 (b), (d), (e), and (f)? (h)(3)(i)		
Are employees who wear respirators allowed to wash their faces and respirator facepieces as needed to prevent potential skin irritation associated with respirator use? (h)(3)(ii)		

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	YES	NO
(i) **Emergency Situations.** (i)		
Has a written plan for emergency situations been developed for each workplace in which DBCP is present? (i)(1)(i)		
Are appropriate portions of the plan implemented in the event of an emergency? (i)(1)(ii)		
Are employees engaged in correcting emergency conditions equipped as required in paragraphs (h) and (j) of this section until the emergency is abated? (i)(2)		
Are employees not engaged in correcting the emergency removed and restricted from the area and normal operations in the affected area not resumed until the emergency is abated? (i)(3)		
Where there is a possibility of employee exposure due to the occurrence of an emergency, is a general alarm installed and maintained to promptly alert employees to such occurrences? (i)(4)		
Is medical surveillance in accordance with paragraph (m)(6) below provided for any employee exposed to DBCP in an emergency situation? (i)(5)		
Is the monitoring required by paragraph (f) above conducted after an emergency? (i)(6)(i)		
NOTE: In workplaces not normally subject to periodic monitoring, the employer may terminate monitoring when two consecutive measurements indicate exposures below the permissible limit. (i)(6)(ii)		
(j) **Protective Clothing and Equipment.** (j)		
Where there is any possibility of eye or dermal contact with liquid or solid DBCP, are employees provided with and required to wear impermeable protective clothing and equipment to protect the area of the body which may come in contact with DBCP? (j)(1)		
Is such protective equipment and clothing provided at no cost to the employee and does the eye and face protection meet the requirements of 1910.133? (j)(1)		
Are employees required to remove DBCP contaminated work clothing only in change rooms provided in accordance with paragraph (l)(1) below? (j)(2)(i)		
Are employees required to promptly remove any protective clothing and equipment which becomes contaminated with DBCP-containing liquids and solids? (j)(2)(ii)		
Is this contaminated clothing or equipment not reworn until the DBCP has been removed? (j)(2)(ii)		
Are employees prohibited from taking DBCP-contaminated protective devices and work clothing out of the change rooms? (Excepted are those employees authorized to do so for the purpose of laundering, maintenance or disposal.) (j)(2)(iii)		
Are DBCP-contaminated protective devices and work clothing placed and stored in closed containers which prevent dispersion of the DBCP outside the container? (j)(2)(iv)		
Are containers of contaminated protective devices or work clothing labelled in accordance with paragraph (o)(3) below before being taken out of change rooms or the workplace for cleaning, maintenance or disposal? (j)(2)(iv)		
Is the required protective clothing and equipment cleaned, laundered, repaired or replaced as required to maintain its effectiveness? (j)(3)(i)		

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	YES	NO
Is clean protective clothing and equipment provided at least daily to each affected employee? (j)(3)(i)		
Has any person who launders or cleans DBCP-contaminated protective clothing or equipment been informed of the potentially harmful effect of exposure to DBCP? (j)(3)(ii)		
Is the removal of DBCP from protective clothing and equipment by blowing or shaking prohibited? (j)(3)(iii)		
(k) **Housekeeping.** (k)		
Are all workplace surfaces maintained free of visible accumulations of DBCP? (k)(1)(i)		
Is dry sweeping and the use of compressed air for the cleaning of floors and other surfaces prohibited where DBCP dusts or liquids are present? (k)(1)(ii)		
Are either portable units or a permanent system used where vacuuming methods are selected to clean floors and other surfaces? (k)(1)(iii)		
If a portable vacuum is selected, does it meet the following:		
The exhaust shall be attached to the general workplace exhaust ventilation system or collected within the vacuum unit, equipped with high efficiency filters or other appropriate means of contaminant removal, so that DBCP is not reintroduced into the workplace air? (k)(1)(iii)(a)		
Units used to collect DBCP may not be used for other cleaning purposes and shall be labeled as prescribed by paragraph (o)(3) below? (k)(1)(iii)(b)		
Is the cleaning of floors and other surfaces contaminated with DBCP-containings dusts not performed by washing down with a hose, unless a fine spray has first been laid down? (k)(1)(iv)		
Where DBCP is present in a liquid form, or as a resultant vapor, are all containers or vessels containing DBCP enclosed to the maximum extent feasible and tightly covered when not in use? (k)(2)		
Is DBCP waste, scrap, debris, containers or equipment disposed of in sealed bags or other closed containers which prevent dispersion of DBCP outside the container? (k)(3)		
(l) **Hygiene Facilities and Practices.** (l)		
Are clean change rooms equipped with storage facilities for street clothes and separate storage facilities for protective clothing and equipment provided whenever employees are required to wear DBCP protection? (l)(1)		
Are employees working in the regulated area required to shower at the end of the work shift? (l)(2)(i)		
Are employees whose skin becomes contaminated with DBCP-containing liquids and solids required to immediately wash or shower to remove any DBCP from the skin? (l)(2)(ii)		
Is the shower facility in conformance with 1910.141 (d)(3)? (See page J-02) (l)(2)(iii)		
Are lunchroom facilities provided which have a temperature controlled, positive pressure, filtered air supply, and which are readily accessible to employees working in regulated areas? (l)(3)		
Are employees working in the regulated area required to remove protective clothing and wash their hands and face prior to eating? (l)(4)(i)		

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	YES	NO
Is a sufficient number of lavatory facilities provided which comply with 1910.141 (d) (1) and (2)? (See page J-02) (l)(4)(ii)		
Are the following activities prohibited in regulated areas:		
Food or beverages are not present or consumed, smoking products and implements are not present or used, and cosmetics are not present or applied? (l)(5)		
(m) **Medical Surveillance.** (m)		
Is a medical surveillance program made available for employees who work in regulated areas and employees who are subjected to DBCP exposures in an emergency situation? (m)(1)(i)		
Are all medical examinations and procedures performed by or under the supervision of a licensed physician and provided without cost to the employee? (m)(1)(ii)		
At the time of initial assignment and annually thereafter, has each employee who works in a regulated area been provided a medical examination which includes at least the following: (m)(2)		
A medical and occupational history including reproductive history? (m)(2)(i)		
A physical examination, including examination of the genito-urinary tract, testicle size and body habitus, including a determination of sperm count? (m)(2)(ii)		
A serum specimen shall be obtained and the following determinations made by radioimmunoassay techniques utilizing National Institutes of Health (NIH) specific antigen or one of equivalent sensitivity: (m)(2)(iii)		
Serum follicle stimulating hormone (FSH)? (m)(2)(iii)(a)		
Serum luteinizing hormone (LH)? (m)(2)(iii)(b)		
Serum total estrogen (females)? (m)(2)(iii)(c)		
Any other tests deemed appropriate by the examining physician? (m)(2)(iv)		
If an employee for any reason develops signs or symptoms commonly associated with exposure to DBCP, is a medical examination provided which shall include those elements considered appropriate by the examining physician? (m)(3)		
Has the employer provided the following information to the examining physician: (m)(4)		
A copy of this regulation and its appendices? (m)(4)(i)		
A description of the affected employee's duties as they relate to the employee's exposure? (m)(4)(ii)		
The level of DBCP to which the employee is exposed? (m)(4)(iii)		
A description of any personal protective equipment used or to be used? (m)(4)(iv)		
Has the employee been provided with a copy of the examining physician's written opinion containing the following: (m)(5)(i)		
The results of the medical tests performed? (m)(5)(i)(a)		
The physician's opinion as to whether the employee has any detected medical condition which would place the employee at an increased risk of material impairment of health from exposure to DBCP? (m)(5)(i)(b)		

	YES	NO
Any recommended limitations upon the employee's exposure to DBCP or upon the use of protective clothing and equipment such as respirators? **(m)(5)(i)(c)**		
NOTE: The employer shall instruct the physician not to reveal in the written opinion specific findings or diagnoses unrelated to occupational exposure. **(m)(5)(ii)**		
If exposed to DBCP in an emergency situation, has the employee been provided with a sperm count test as soon as practicable, or if the employee has been vasectomized or is unable to produce a semen specimen, the hormone tests contained in paragraph (m)(2)(iii) above? **(m)(6)**		
NOTE: The employer must provide these same tests three months later. **(m)(6)**		
(n) **Employee Information and Training.** **(n)**		
Has a training program been instituted for all employees who may be exposed to DBCP? **(n)(1)(i)**		
Does the program include:		
The information contained in Appendix Z-D*? **(n)(1)(ii)(a)**		
The quantity, location, manner of use, release or storage of DBCP and the specific nature of operations which could result in exposure to DBCP as well as any necessary protective steps? **(n)(1)(ii)(b)**		
The purpose, proper use, and limitations of respirators? **(n)(1)(ii)(c)**		
The purpose and description of the medical surveillance program required by paragraph (m) above? **(n)(1)(ii)(d)**		
A review of this standard, including appendices Z-D, Z-E and Z-F*? **(n)(1)(ii)(e)**		
Is a copy of this standard and its Appendices readily available to all affected employees? **(n)(2)(i)**		
Are all materials relating to the employee information and training program available upon request to the Assistant Secretary of Labor and the Director of NIOSH? **(n)(2)(ii)**		
(o) **Signs and Labels.** **(o)**		
NOTE: The employer may use labels or signs required by other statutes, regulations, or ordinances in addition to or in combination with the signs and labels required below; however, no statement which conttradicts or detracts shall appear on or near a DBCP warning sign or label. **(o)(1)**		
Are regulated areas posted with signs bearing the legend: DANGER 1,2-Dibromo-3-chloropropane (Insert appropriate trade or common names) CANCER HAZARD AUTHORIZED PERSONNEL ONLY RESPIRATOR REQUIRED **(o)(2)**		
Are precautionary labels affixed to all containers of DBCP and of products containing DBCP in the workplace? **(o)(3)(i)**		
Do the labels remain affixed when the DBCP or products containing DBCP are sold, distributed, or otherwise leave the employer's workplace? **(o)(3)(i)**		

*See Self-Inspection Appendix

	YES	NO
NOTE: Where DBCP or products containing DBCP are sold, distributed or otherwise leave the employer's workplace bearing appropriate labels required by EPA under the regulations in 40 CFR Part 162, the labels required above need not be affixed. **(o)(3)(i)**		
Are the precautionary labels required by this paragraph readily visible and legible, and do they bear the legend: DANGER 1,2-Dibromo-3-chloropropane CANCER HAZARD **(o)(3)(ii)**		
(p) **Recordkeeping.** **(p)**		
Is an accurate record of all monitoring required by (f) above, established and maintained? **(p)(1)(i)**		
Does the record include:		
The dates, number, duration and results of each of the samples taken, including a description of the sampling procedures used to determine representative employee exposure? **(p)(1)(ii)(a)**		
A description of the sampling and analytical methods used? **(p)(1)(ii)(b)**		
Type of respiratory protective devices worn, if any? **(p)(1)(ii)(c)**		
Name, social security number and job classification of the employee monitored and of all other employees whose exposure the measurement is intended to represent? **(p)(1)(ii)(d)**		
Is this record maintained for at least 40 years, or the duration of employment plus 20 years, whichever is longer? **(p)(1)(iii)**		
Is an accurate record established and maintained for each employee subject to medical surveillance required by (m) above? **(p)(2)(i)**		
Does the record include:		
The name and social security number of the employee? **(p)(2)(ii)(a)**		
A copy of the physician's written opinion? **(p)(2)(ii)(b)**		
Any employee medical complaints related to DBCP exposure? **(p)(2)(ii)(c)**		
A copy of the information provided the physician as required by (m)(4)(ii) - (iv) above? **(p)(2)(ii)(d)**		
A copy of the employee's medical and work history? **(p)(2)(ii)(e)**		
Is this record maintained for at least 40 years, or the duration of employment plus 20 years, whichever is longer? **(p)(2)(iii)**		
Are all records required by this section made available upon request to the Assistant Secretary of Labor and the Director of NIOSH for examination and copying? **(p)(3)(i)**		
Are all employee exposure monitoring records made available for examination and copying to affected employees or their designated representatives? **(p)(3)(ii)**		
Are former employees and the former employees' designated representatives given access to such records as will indicate the former employees' own exposure to DBCP? **(p)(3)(iii)**		

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	YES	NO
Are employee medical records, required to be maintained by this section, made available upon request for examination and copying to the employee or former employee, and to a physician or other individual designated by the affected employee or former employee? (p)(3)(iv)		
Has the following been accomplished when an employer ceases to do business:		
The successor employer shall receive and retain all records required to be maintained for the prescribed period? (p)(4)(i)		
When there is no successor employer to receive and retain the records, the employer shall transmit these records by mail to the Director of NIOSH? (p)(4)(ii)		
Are the required records transmitted by mail to the Director of NIOSH at the expiration of the retention period? (p)(4)(iii)		
(q) **Observation of Monitoring.** (q)		
Are affected employees, or their designated representatives, provided an opportunity to observe any required monitoring of employee exposure to DBCP? (q)(1)		
Are observers provided necessary protective clothing or equipment, and are they required to comply with all applicable safety and health procedures when entering regulated areas? (q)(2)(i)		
Without interfering with the monitoring or measurement, are observers entitled to:		
Receive an explanation of the measurement procedures? (q)(2)(ii)(a)		
Observe all steps related to the measurement of airborne concentrations of DBCP performed at the place of exposure? (q)(2)(ii)(b)		
Record the results obtained? (q)(2)(ii)(c)		
(r) **Appendices**		
The information contained in the appendices (Z-D, Z-E and Z-F*) is not intended, by itself, to create any additional obligations not otherwise imposed or to detract from any existing obligation. (r)		

*See Self-Inspection Appendix

YES	NO

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	YES	NO

The following permanent standard became effective November 2, 1978, except that:

Monitoring and medical surveillance conducted since January 17, 1978 under the provisions of the emergency temporary standard may be relied upon to meet the initial monitoring and initial medical surveillance requirements. (s)(2)

Training programs must be implemented by January 2, 1979. (s)(3)

Engineering and work practice controls required by paragrpah (g) shall be implemented no later than November 2, 1980. (s)(4)

(a) **Scope and Application.** (a)

This section applies to all occupational exposures to acrylonitrile (AN), Chemical Abstracts Service Registry No. 000107131, chemical formula CH_2=CHCN. (a)(1)

This section does not apply to exposures which result solely from the processing, use, and handling of the following materials: (a)(2)

ABS resins, SAN resins, nitrile barrier resins, solid nitrile elastomers, and acrylic and modacrylic fibers, when these listed materials are in the form of finished polymers, and products fabricated from such finished polymers. (a)(2)(i)

Materials made from and/or containing AN for which objective data is reasonably relied upon to demonstrate that the material is not capable of releasing AN in airborne concentrations in excess of 1 part per million (ppm) as an eight- (8)-hour time-weighted (TWA) under the expected conditions of processing, use, and handling which will cause the greatest possible release. (a)(2)(ii)

Solid materials made from and/or containing AN which will not be heated above 170°F during handling, use or processing. (a)(2)(iii)

NOTE: An employer relying upon exemption under (a)(2)(ii) above shall maintain records of the objective data supporting that exemption, and of the basis of the employer's reliance on the data as provided in (q).

(c) **Permissible Exposure Limits (PEL).** (c)

Are the necessary steps taken to assure that no employee is exposed to an airborne concentration of AN in excess of: (c)(1)

Two (2) parts per million parts of air (2 ppm) as an 8-hour time-weighted average (TWA) (TWA Limit)? (c)(1)(i)

Ten (10) ppm as averaged over any fifteen- (15)-minute period during the working day (ceiling limit)? (c)(1)(ii)

Are the necessary steps taken to assure that no employee is exposed to skin contact or eye contact with liquid AN? (c)(2)

NOTE: "Liquid AN" means AN monomer in liquid form, the liquid or semi-liquid polymer intermediates, including slurries, suspensions, emulsions, and solutions, produced during the polymerization of AN.

(d) **Notification of Regulated Areas and Emergencies.** (d)

Is the following information reported to the OSHA Area Office within 30 days following the establishment of a regulated area pursuant to (f) below: (d)(1)

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	YES	NO

The address and location of each establishment which has one or more regulated areas? (d)(1)(i)

The locations, within the establishment, of each regulated area? (d)(1)(ii)

A brief description of each process or operation which results in employee exposure to AN in regulated areas? (d)(1)(iii)

The number of employees engaged in each process or operation within each regulated area which results in exposure to AN, and an estimate of the frequency and degree of exposure that occurs? (d)(1)(iv)

NOTE: Whenever there has been a significant change in the information required to be reported, the employer shall promptly provide the new information to the OSHA Area Office.

Are emergencies, and the facts obtainable at that time, reported to the OSHA Area Office within 72 hours of the occurrence? (d)(2)

(e) **Exposure Monitoring.** (e)

Have air samples been taken and measured to determine airborne exposure levels representative of each employee's exposure to AN over an 8-hour period? (e)(1)(i)

NOTE: For the purpose of this standard, employee exposure is that exposure which would occur if the employee were not using a respirator. (e)(1)(ii)

Has initial monitoring been conducted of each workplace and work operation to accurately determine the airborne concentrations of AN to which employees may be exposed? (e)(2)

NOTE: If the monitoring reveals employee exposure to be below the "action level," the employer may discontinue monitoring for that employee. "Action Level" means a concentration of AN of 1ppm as an 8-hour TWA. (e)(3)(i)

Is monitoring repeated at least quarterly for affected employees when measurements reveal exposure to be at or above the action level (1 ppm) but below the permissible exposure limits (PEL)? (e)(3)(ii)

Is such quarterly monitoring continued until at least two consecutive measurements, taken at least 7 days apart, are below the action level (may be discontinued thereafter)? (e)(3)(ii)

Is monitoring repeated at least monthly for affected employees when measurements reveal exposure to be in excess of the permissible exposure limits (PEL)? (e)(3)(iii)

Is such monthly monitoring continued until at least two consecutive measurements, taken at least 7 days apart, are below the PEL (quarterly thereafter)? (e)(3)(iii)

Is monitoring repeated whenever there has been a production, process, control, or personnel change which may result in any new or additional exposure to AN, or whenever the employer has reason to suspect new or additional exposure? (e)(4)

Is each employee notified in writing, within 5 working days after receipt of the monitoring results, of the measurements which represent that employee's exposure? (e)(5)(i)

	YES	NO
Whenever the PEL is exceeded, does the written notification include a statement that the permissible limit was exceeded, and the corrective actions being taken to reduce exposure to or below the PEL? (e)(5)(ii)		
Does the method of measurement have an accuracy, with a confidence level of 95% to within plus or minus 35% for concentrations of AN at or above the PEL, and plus or minus 50% for concentrations below the PEL? (e)(6)		
(f) **Regulated Areas.** (f)		
Are regulated areas established where concentrations of AN are in excess of the PEL? (f)(1)		
Are regulated areas demarcated and segregated from the rest of the workplace in such manner as to minimize the number of persons who will be exposed to AN? (f)(2)		
Is access to regulated areas limited to authorized persons? (f)(3)		
Are steps taken to assure that food or beverages are not present or consumed, tobacco products are not present or used, and cosmetics are not applied in the regulated area? (f)(4)		
(g) **Methods of Compliance.** (g)		
Are feasible engineering and work practice controls instituted to redice and maintain employee exposures at or below the PEL (by Nov. 2, 1980)? (g)(1)(i)		
Where such feasible engineering and work practice controls are not sufficient to reduce employee exposures to or below the PEL, are they nonetheless used to reduce exposures to the lowest level achievable and then supplemented by use of respiratory protection? (g)(1)(ii)		
Is a written program established and implemented to reduce employee exposures to or below the PEL solely by means of engineering and work practice controls as required by (g)(1) above? (g)(2)(i)		
Does the written program include at least the following: (g)(2)(ii)		
A description of each operation or process resulting in employee exposure above the PEL? (g)(2)(ii)(a)		
An outline of the nature of the engineering controls and work practices to be applied to the operation or process in question? (g)(2)(ii)(b)		
A report of the technology considered in meeting the PEL? (g)(2)(ii)(c)		
A schedule for implementation of engineering and work practice controls for the operation or process, which shall project completion no later than November 2, 1980? (g)(2)(ii)(d)		
Other relevant information? (g)(2)(ii)(e)		
Have the implementation steps as set forth in the written program been completed by the dates established in the schedule? (g)(2)(iii)		
Are written plans for these compliance programs available at the worksite for examination and copying by the Assistant Secretary of Labor, the Director of NIOSH, and any affected employee or representative? (g)(2)(iv)		

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	YES	NO
Are these plans revised at least every six months to reflect the current status of the program? (g)(2)(v)		
(h) **Respiratory Protection.** (h)		
Are employees provided with and required to wear respirators in the following circumstances: (h)(1)		
During the time period necessary to install or implement feasible engineering and work practice controls? (h)(1)(i)		
In work operations, such as maintenance and repair activities or reactor cleaning, in which the employer establishes that engineering and work practice controls are not feasible? (h)(1)(ii)		
In work situations where feasible engineering and work practice controls are not yet sufficient to reduce exposure to or below the PEL? (h)(1)(iii)		
In emergencies? (h)(1)(iv)		
When respirators are required, is an appropriate respirator selected based on the following concentrations or condition of use (as set forth in Table 1)? (h)(2)(i)		
Are respirators provided at no cost to the employees, and their use assured when conditions so require? (h)(2)(i)		
Are respirators selected from among those approved by the National Institute for Occupational Safety and Health (NIOSH) under the program of 30 CFR Part 11? (h)(2)(ii)		
Does the respiratory protection program meet the requirements of 1910.134 (b),(d),(e) and (f)? (h)(3)(i)		
When air-purifying respirators (chemical cartridge or canister type) are used, is the air-purifying canister or cartridge replaced prior to the expiration of their service life or at the completion of each shift, whichever occurs first? (h)(3)(ii)		
Is a label attached to the cartridge or canister to indicate the date and time at which it is first installed on the respirator? (h)(3)(ii)		
Is fit testing of respirators performed in accordance with the following? (h)(3)(iii)		
The employer shall perform qualitative fit tests at the time of initial fitting and at least semi-annually thereafter for each employee wearing respirators. (h)(3)(iii)(a)		
Each employer with more than 10 employees wearing negative pressure respirators shall perform quantitative fit testing at the time of initial fitting and at least semi-annually thereafter for each such employee. (h)(3)(iii)(b)		
Are employees who wear respirators allowed to wash their faces and wipe clean the face-to-facepiece seals on their respirators to minimize potential skin irritation associated with respirator use? (h)(3)(iv)		
(i) **Emergency Situations.** (i)		
Has a written plan for emergency situations been developed for each workplace in which AN is present? (i)(1)(i)		
Are appropriate portions of the plan implemented in the event of an emergency? (i)(1)(i)		
Are employees engaged in correcting emergency conditions equipped with respiratory protection as required by (h) above, until the emergency is abated? (i)(1)(ii)		
Are employees not engaged in correcting the emergency evacuated from the area and not permitted to return until the emergency is abated? (i)(1)(iii)		

	YES	NO
Where there is the possibility of employee exposure in excess of the ceiling limit (10 ppm/15-minute period), is a general alarm installed and used to alert employees promptly to such occurrences? (i)(2)		
(j) Protective Clothing and Equipment. (j)		
Where eye or skin contact with liquid AN may occur, are employees provided with and required to wear impermeable protective clothing or other equipment to protect any area of the body which may come in contact with liquid AN? (j)(1)		
Is such protective equipment and clothing provided at no cost to the employee and does it meet the requirements of 1910.132 and 133? (j)(1)		
Are steps taken to clean, launder, maintain, or replace protective clothing and equipment as needed to maintain their effectiveness? (j)(2)(i)		
Is impermeable protective clothing, which contacts or is likely to have contacted liquid AN, decontaminated before being removed from the employee? (j)(2)(ii)		
Is an employee whose nonimpermeable clothing becomes wetted with liquid AN, required to immediately remove that clothing and proceed to shower? (j)(2)(iii)		
Is such clothing decontaminated before it is removed from the regulated area? (j)(2)(iii)		
Are employees prohibited from removing protective clothing or equipment from the change room? (Excepted are those employees authorized to do so for the purpose of laundering, maintenance or disposal.) (j)(2)(iv)		
Has any person who launders or cleans protective clothing or equipment been informed of the potentially harmful effects of exposure to AN? (j)(2)(v)		

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	YES	NO
(k) Housekeeping. (k)		
Are all surfaces maintained free of visible accumulations of liquid AN? (k)(1)		
For operations involving liquid AN, has a program been instituted for detection of leaks and spills, including regular visual inspections? (k)(2)		
Where spills are detected, have all surfaces that contacted the liquid AN been decontaminated and are employees not engaged in decontamination activities required to leave the area of the spill, and not permitted to return until decontamination is completed? (k)(3)		
(l) Waste Disposal. (l)		
Is AN waste, scrap, debris, bags, containers, or equipment decontaminated before being incorporated in the general waste disposal system? (l)		
(m) Hygiene Facilities and Practices. (m)		
Are the facilities required by 1910.141, including clean change rooms and shower facilities, provided and use assured for those employees exposed to airborne concentrations of AN above the PEL, or where employees are required to wear protective clothing or equipment as per (j) above? (m)(1)		
Are employees who wear protective clothing or equipment for protection from skin contact with liquid AN required to shower at the end of the work shift? (m)(2)		
In the event of skin or eye exposure to liquid AN, is the affected employee required to shower immediately to minimize the danger of skin absorption? (m)(3)		
Are employees working in the regulated area required to wash their hands and faces prior to eating? (m)(4)		

TABLE 1.—Respiratory Protection for Acrylonitrile (AN)

Concentration of AN or condition of use	Respirator type
(a) Less than or equal to 20 ppm . . .	(1) Chemical cartridge respirator with organic vapor cartridge(s) and half-mask facepiece; or (2) Supplied air respirator with half-mask facepiece.
(b) Less than or equal to 100 ppm or maximum use concentration (MUC) of cartridges or canisters, whichever is lower.	(1) Full facepiece respirator with (A) organic vapor cartridges, (B) organic vapor gas mask chin-style, or (C) organic vapor gas mask canister, front- or back-mounted; (2) Supplied air respirator with full facepiece; or (3) Self-contained breathing apparatus with full facepiece.
(c) Less than or equal to 4,000 ppm	(1) Supplied air respirator operated in the positive pressure mode with full facepiece, helmet, suit, or hood.
(d) Greater than 4,000 ppm or unknown concentration	(1) Supplied air and auxiliary self-contained breathing apparatus with full facepiece in positive pressure mode; or (2) Self-contained breathing apparatus with full facepiece in positive pressure mode.
(e) Firefighting	Self-contained breathing apparatus with full facepiece in positive pressure mode.
(f) Escape	(1) Any organic vapor respirator, or (2) Any self-contained breathing apparatus.

	YES	NO
(n) Medical Surveillance. (n)		
Has a program of medical surveillance been instituted for each employee who is or will be exposed to AN at or above the action level (1 ppm), without regard to the use of respirators? (n)(1)(i)		
Is each such employee provided an opportunity for medical examinations and tests in accordance with this paragraph? (n)(1)(i)		
Are all medical examinations and procedures performed by or under the supervision of a licensed physician, and provided without cost to the employee? (n)(1)(ii)		
At the time of initial assignment, or upon institution of the medical surveillance program, has each affected employee been provided an opportunity for a medical examination that includes at least the following elements: (n)(2)		
A work history and medical history with special attention to skin, respiratory, and gastrointestinal systems, and those nonspecific symptoms, such as headache, nausea, vomiting, dizziness, weakness, or other central nervous system dysfunctions that may be associated with acute or with chronic exposure to AN? (n)(2)(i)		
A complete physical examination giving particular attention to the peripheral and central nervous system, gastrointestinal system, respiratory system, skin, and thyroid? (n)(2)(ii)		
A 14- by 17-inch posteroanterior chest X-ray? (n)(2)(iii)		
Further tests of the intestinal tract, including fecal occult blood screening, for all workers 40 years of age or older, and for any other affected employees for whom, in the opinion of the physician, such testing is appropriate? (n)(2)(iv)		
Is the examination specified in (n)(2) above provided at least annually for all employees exposed above the action level (1 ppm)? (n)(3)(i)		
If an employee has not had the examination specified in (n)(2) within 6 months preceding termination of employment, is such examination available to the employee prior to such termination? (n)(3)(ii)		
If an employee for any reason develops signs or symptoms which may be associated with exposure to AN, is an appropriate examination and emergency medical treatment provided? (n)(4)		
Has the employer provided the following information to the examining physician: (n)(5)		
A copy of this standard and its appendices? (n)(5)(i)		
A description of the affected employee's duties as they relate to the employee's exposure? (n)(5)(ii)		
The employee's representative exposure level? (n)(5)(iii)		
The employee's anticipated or estimated exposure level (for pre-placement examinations or in cases of exposure due to an emergency)? (n)(5)(iv)		
A description of any personal protective equipment used or to be used? (n)(5)(v)		
Information from previous medical examinations of the affected employee, which is not otherwise available to the examining physician? (n)(5)(vi)		

	YES	NO
Has a written opinion been obtained from the examining physician which includes: (n)(6)(i)		
The results of the medical examination and tests performed? (n)(6)(i)(a)		
The physician's opinion as to whether the employee has any detected medical condition(s) which would place the employee at an increased risk of material impairment of the employee's health from exposure to AN? (n)(6)(i)(b)		
Any recommended limitation upon the employee's exposure to AN or upon the use of protective clothing and equipment such as respirators? (n)(6)(i)(c)		
A statement that the employee has been informed by the physician of the results of the medical examination and any medical conditions which require further examination or treatment? (n)(6)(i)(d)		
Was the physician instructed not to reveal in the written opinion, specific findings or diagnoses unrelated to occupational exposure to AN? (n)(6)(ii)		
Has the affected employee been provided with a copy of the written opinion? (n)(6)(iii)		
(o) Employee Information and Training. (o)		
Has a training program been instituted and participation assured for all employees exposed to AN above the action level, all employees whose exposures are maintained below the action level by engineering and work practice controls and all employees subject to potential skin or eye contact with liquid AN? (o)(1)(i)		
Is training provided at the time of initial assignment, or upon institution of the training program, and at least annually thereafter, and is each employee informed of the following: (o)(1)(ii)		
The information contained in appendices A and B*? (o)(1)(ii)(a)		
The quantity, location, manner of use, release, or storage of AN, and the specific nature of any operation which could result in exposure to AN, as well as any necessary protective steps? (o)(1)(ii)(b)		
The purpose, proper use, and limitation of respirators and protective cloth clothing? (o)(1)(ii)(c)		
The purpose and a description of the medical surveillance program required by (n) above? (o)(1)(ii)(d)		
The emergency procedures developed, as required by (i) above? (o)(1)(ii)(e)		
Engineering and work practice controls, their function, and the employee's relationship to these controls? (o)(1)(ii)(f)		
A review of this standard? (o)(1)(ii)(g)		
Is a copy of this standard and its appendices readily available to all affected employees? (o)(2)(i)		
Are all materials relating to the employee information and training program available upon request to the Assistant Secretary of Labor and the Director of NIOSH? (o)(2)(ii)		

*See pages Z-49f thru Z-50.

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	YES	NO

(p) Signs and Labels. (p)

NOTE: The employer may use lables or signs required by other statutes, regulations, or ordinances in addition to or in combination with the signs and labels required below; however, no statement which contradicts or detracts shall appear on or near an AN warning sign or label. (p)(1)

Are signs bearing the following legend posted to indicate clearly all workplaces where AN concentrations exceed the permissible exposure limits (PEL)? (p)(2)(i)

DANGER

ACRYLONITRILE (AN)

CANCER HAZARD

AUTHORIZED PERSONNEL ONLY

RESPIRATORS MAY BE REQUIRED

Are the signs required by this paragraph illuminated and cleaned as necessary so that the legend is readily visible? (p)(2)(ii)

Are precautionary labels affixed to all containers of liquid AN and AN-based materials not exempted under (a)(2) of this standard? (p)(3)(i)

Do the labels remain affixed when the materials are sold, distributed, or otherwise leave the employer's workplace? (p)(3)(i)

Are the precautionary labels required by this paragraph readily visible and legible, and do they bear the legend: (p)(3)(ii)

DANGER

CONTAINS ACRYLONITRILE (AN)

CANCER HAZARD

(q) Recordkeeping. (q)

Where the processing, use, and handling of materials made from or containing AN are exempted pursuant to (a) (2) (ii) above, is an accurate record of objective data maintained to support the exemption, and does it include at least the following information: (q)(1)(i)&(ii)

The material qualifying for exemption? (q)(1)(ii)(a)

The source of the objective data? (q)(1)(ii)(b)

The testing protocol, results of testing, and/or analysis of the material for the release of AN? (q)(1)(ii)(c)

A description of the operation exempted and how the data supports the exemption? (q)(1)(ii)(d)

Other data relevant to the operations, materials, and processing covered by the exemption? (q)(1)(ii)(e)

Is the record maintained for the duration of the employer's reliance upon such objective data? (q)(1)(iii)

Is an accurate record of all monitoring required by (e) above, established and maintained? (q)(2)(i)

Does the record include:

The dates, number, duration, and results of each of the samples taken, including a description of the sampling procedure used to determine representative employee exposure? (q)(2)(ii)(a)

	YES	NO

A description of the sampling and analytical methods used and the data relied upon to establish that the methods used meet the accuracy and precision requirements of (e)(6)? (q)(2)(ii)(b)

Type of respiratory protective devices worn, if any? (q)(2)(ii)(c)

Name, social security number, and job classification of the employee monitored and of all other employees whose exposure the measurement is intended to represent? (q)(2)(ii)(d)

Is this record maintained for at least 40 years, or the duration of employment plus 20 years, which is longer? (q)(2)(iii)

Is an accurate record established and maintained for each employee subject to medical surveillance required by (n) above? (q)(3)(i)

Does the record include:

A copy of the physician's written opinions? (q)(3)(ii)(a)

Any employee medical complaints related to exposure of AN? (q)(3)(ii)(b)

A copy of the information provided to the physician as required by (n)(5)? (q)(3)(ii)(c)

A copy of the employee's medical and work history? (q)(3)(ii)(d)

Is this record maintained for at least 40 years, or the duration of employment plus 20 years, whichever is longer? (q)(3)(iii)

Are all records required by this section made available upon request to the Assistant Secretary of Labor and the Director of NIOSH for examination and copying? (q)(4)(i)

Are the records required by paragraph (q)(1) and (2) of this section made available upon request, for examination and copying, to affected employees, former employees, or their designated representatives? (q)(4)(ii)

Are employee medical records, required to be maintained by this section, made available upon request, for examination and copying, to the affected employee or former employee, or to a physician designated by the affected employee or former employee? (q)(4)(iii)

Has the following been accomplished when an employer ceases to do business?

The successor employer shall receive and retain all records required to be maintained for the prescribed period. (q)(5)(i)

When there is no successor employer to receive and retain the records, the employer shall transmit these records by mail to the Director of NIOSH. (q)(5)(ii)

Is the Director of NIOSH notified 3 months prior to disposal of required records which have met the mandatory retention period, and are such records transmitted to the Director if he requests them within the 3-month period? (q)(5)(iii)

(r) Observation of Monitoring. (r)

Are affected employees, or their designated representatives, provided an opportunity to observe any required monitoring of employee exposure to AN? (r)(1)

	YES	NO
Are observers provided necessary personal protective clothing or equipment, and are they required to comply with all applicable safety and health procedures when entering regulated areas? (r)(2)(i)		
Without interfering with the monitoring, are observers entitled to:		
Receive an explanation of the measurement procedures? (r)(2)(ii)(a)		
Observe all steps related to the measurement of airborne concentrations of AN performed at the place of exposure? (r)(2)(ii)(b)		
Record the results obtained? (r)(2)(ii)(c)		

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	YES	NO
(t) **Appendices.** (t)		
The information contained in the appendices (A,B,C, and D*) is not intended, by itself, to create any additional obligations not otherwise imposed, or to detract from any obligation. (t)		

(Next page is Z-53)

*See Self-Inspection Appendix

1910.1047 ETHYLENE OXIDE

YES	NO

(a) Scope and Application

This section applies to all occupational exposures to ethylene oxide (EtO), except as provided in paragraph (a)(2). **(a)(1)**

This section does not apply to:

processing, use, or handling of products containing EtO where objective data are reasonably relied upon that demonstrate the product is not capable of releasing EtO in airborne concentrations at or above the action level (0.5 ppm calculated as an eight (8)-hour time-weighted average). **(a)(2)**

Supporting records of the objective data shall be maintained by the employer for products claimed exempt under paragraph (a)(2). (See also paragraph (K)(1) below.) **(a)(3)**

(b) Definitions

"Action level" — a concentration of airborne EtO of 0.5 ppm calculated as an eight (8)-hour time-weighted average.

"Assistant Secretary" — the Assistant Secretary of Labor for Occupational Safety and Health, or designee.

"Authorized person" — any person specifically authorized by the employer whose duties require him or her to enter a regulated area, or

— any person entering such an area as a designated representative of employees for the purpose of exercising the right to observe monitoring and measuring procedures under paragraph one (1) of this section, or

— any other person authorized by the Act or regulations issued under the Act.

"Director" — the Director of NIOSH, or designee.

"Emergency" — any occurrence such as, but not limited to, equipment failure, rupture of containers, or failure of control equipment that is likely to or does result in an unexpected significant release of EtO.

"Employee exposure" — exposure to airborne EtO which would occur if the employee were not using respiratory protective equipment.

"Ethylene oxide" or "EtO" — the three-membered ring organic compound with chemical formula C_2H_4O.

(c) Permissible Exposure Limits (PEL)

Employer shall ensure that no employee is exposed to airborne concentration of EtO in excess of 1 ppm as an 8-hour TWA.

(d) Exposure Monitoring

General Monitoring **(d)(1)**

Determinations of employees exposure shall be made from breathing zone air representative of the 8-hour TWA of each employee. **(d)(1)(i)**

Representative 8-hour TWA employee exposure shall be on the basis of one or more samples representing:

— full-shift exposure for each shift, and for each job classification in each work area. **(d)(1)(ii)**

— where it can be documented that exposure levels are equivalent for similar operations in different work-shifts, a representative employee exposure for the operation during one shift is acceptable. **(d)(1)(iii)**

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YES	NO

Initial Monitoring **(d)(2)**

Employers covered by this standard, except as provided in (a)(2) or (d)(2)(ii), shall perform initial monitoring to accurately determine airborne concentrations of EtO to which employees may be exposed. **(d)(2)(i)**

Results from exposure monitoring accomplished after June 15, 1983 may be used to satisfy requirements of paragraph (d)(2)(i). **(d)(2)(ii)**

Monitoring Frequency (periodic monitoring) **(d)(3)**

If monitoring shows employee exposure at or above action level (0.5 ppm) but at or *below* the 8-hour TWA monitoring for each employee shall be repeated at least every six months. **(d)(3)(i)**

If monitoring reveals employee exposure *above* the 8-hour TWA, monitoring shall be repeated at least every three months. **(d)(3)(ii)**

Monitoring schedule may be changed from quarterly to semi-annually for any employee whose exposure levels indicated by at least two consecutive measurements taken at least 7 days apart indicate the exposure has decreased to or below the 8-hour TWA. **(d)(3)(iii)**

Termination of Monitoring **(d)(4)**

If initial monitoring shows employee exposure below action level (0.5 ppm) monitoring may be discontinued for those employees. **(d)(4)(i)**

If on periodic monitoring two consecutive measurements taken at least 7 days apart are below the action level, monitoring for employees represented may be discontinued. **(d)(4)(ii)**

Additional Monitoring **(d)(5)**

Exposure monitoring shall be reinstituted whenever there has been a change in the production process, control equipment, personnel or work practices that may result in new or additional exposures. **(d)(5)**

Accuracy of Monitoring **(d)(6)**

Monitoring shall be accurate to a confidence level of 95 percent within:

± 25% at the 1 ppm TWA
± 35% at 0.5 ppm action level **(d)(6)**

Employee Notification of Monitoring Results **(d)(7)**

Within 15 working days after receipt of monitoring results affected employees are to be notified in writing, either individually or by posting results in appropriate, accessible locations. **(d)(7)(i)**

The written notice shall show the corrective action being taken by the employer to reduce employee exposure to or below the PEL if monitoring indicates the PEL has been exceeded. **(d)(7)(ii)**

(e) Regulated Areas

A regulated area shall be established wherever occupational exposure to airborne concentrations of EtO exceeds or may exceed the TWA. **(e)(1)**

Only authorized persons shall be permitted to enter regulated areas. **(e)(2)**

Regulated areas shall be marked off to minimize the number of employees within the regulated areas. **(e)(3)**

	YES	NO

(f) Methods of Compliance

Engineering controls and work practices. (f)(1)

Engineering controls and work practices shall be instituted to reduce or maintain employee exposure to or below the TWA, except to the extent such controls are not feasible. (f)(1)(i)

Respiratory protection is to be used to supplement engineering controls and work practices, if needed, whenever such feasible controls and practices are not sufficient to reduce employee exposure to required levels (see also paragraph (g)). (f)(1)(ii)

Engineering controls are generally *infeasible* for the following operations: (f)(1)(iii)

— Collection of quality assurance sampling from sterilized materials.
— Removal of biological indicators from sterilized materials.
— Loading and unloading of tank cars.
— Changing of ethylene oxide tanks on sterilizers.
— Vessel cleaning.

NOTE: Engineering controls for these operations are required only where the Assistant Secretary demonstrates such controls are feasible. (f)(1)(iii)

Compliance Programs (f)(2)

The compliance program shall include:

— A written program required where the TWA is exceeded, detailing engineering and work practices to be implemented, and use of respiratory protection where required or permitted. (f)(2)(i)

— A schedule for periodic leak detection surveys, and
— A written plan for emergency situations (see paragraph (h)(i)). (f)(2)(ii)

The written plan shall be furnished upon request for examination and copying to the Assistant Secretary, the Director, affected employees and designated employee representatives. (f)(2)(iii)

The written plan shall be reviewed and if necessary updated at least every 12 months to reflect significant changes in the compliance program. (f)(2)(iii)

Employee rotation scheduling as a means of compliance with the TWA is not permitted. (f)(2)(iv)

(g) Respiratory Protection and Personal Protective Equipment

General (g)(1)

Where required by this section, the employer shall provide respirators and ensure that they are used, including for the following circumstances:

— During interval necessary to install or implement engineering and work practice controls. (g)(1)(i)

— In operations such as maintenance, repair activities, vessel cleaning, or activities for which engineering and work practice controls are not feasible. (g)(1)(ii)

— Work situations where feasible controls are not yet sufficient to reduce exposure to or below the TWA. (g)(1)(iii)

— In emergencies. (g)(1)(iv)

YES	NO

Respirator Selection (g)(2)

Appropriate respirators, where required, shall be selected from Table 1, 1910.1047. (See page z-00.) (g)(2)(i)

Respirators shall be selected from among those jointly approved as acceptable for protection against EtO by the Mine Safety and Health Administration (MSHA), and NIOSH under provisions of 30 CFR Part 11. (g)(2)(ii)

Respirator Program (g)(3)

Required respirator programs shall be in compliance with 29 CFR 1910.134 (b), (d), (e), and (f). (g)(3)

Protective Clothing and Equipment (g)(4)

Appropriate protective clothing and equipment shall be selected and supplied by the employer, and at no cost to the employee in accordance with 29 CFR 1910.132 and 1910.133 to protect any area of the body that may come in contact with liquid EtO or EtO in solution. (g)(4)

The employer shall ensure that the employee wears the protective clothing and equipment provided. (g)(4)

(h) Emergency Situations

Written Plan (h)(1)

A written plan for emergency situations is required for each workplace where there is a possibility of an emergency. (h)(1)(i)

The written plan shall specifically provide that employees engaged in correcting emergency conditions are to be equipped with respiratory protection until the emergency is abated. (h)(1)(ii)

The plan shall include elements prescribed in 29 CFR 1910.38 "Employee Emergency Plans and Fire Prevention Plans." (h)(1)(iii)

Alerting Employees (h)(2)

A means to promptly alert employees of the possibility of exposure to EtO due to an emergency shall be developed. (h)(2)

In event of such emergency affected employees shall be immediately evacuated from the area. (h)(2)

(i) Medical Surveillance

General (i)(1)

Employees Covered: (i)(1)(i)

(a) A medical surveillance program shall be instituted for all employees who are or may be exposed to EtO at or above the action level, without regard to use of respirators, for at least 30 days a year.

(b) Medical examinations and consultations shall be made available to all employees exposed to EtO in an emergency situation.

Examination by a Physician (i)(1)(ii)

Required medical examinations and procedures are to be performed by or under supervision of a licensed physician, at a reasonable time and place, and provided at no cost to the employee, and with no loss of pay. (i)(1)(ii)

Condition of Use or Concentration of Airborne EtO (ppm)	Minimum Required Respirator
Equal to or less than 50.	(a) Full facepiece respirator with EtO approved canister, front- or back-mounted.
Equal to or less than 2,000.	(a) Positive-pressure supplied air respirator, equipped with full facepiece, hood, or helmet, or
	(b) Continuous-flow supplied air respirator (positive pressure) equipped with hood, helmet or suit.
Concentration above 2,000 or unknown concentration (such as in emergencies).	(a) Positive-pressure self-contained breathing apparatus (SCBA), equipped with full facepiece, or
	(b) Positive-pressure full facepiece supplied air respirator equipped with an auxiliary positive-pressure self-contained breathing apparatus.
Firefighting	(a) Positive pressure self-contained breathing apparatus equipped with full facepiece.
Escape	(a) Any respirator described above.
Note — Respirators approved for use in higher concentrations are permitted to be used in lower concentrations.	

Table 1 — Minimum Requirements for Respiratory Protection for Airborne EtO

Medical Examination and Consultations (i)(2)

Frequency: (i)(2)(i)

The following schedules shall apply for each employee covered under paragraph (i)(1)(i):

(a) Prior to assignment of employee to an area where exposure may be at or above the action level for at least 30 days a year.

(b) At least annually for each employee exposed at or above action level for at least 30 days in the past year.

(c) At termination of employment or reassignment to an area where exposure to EtO is not at or above the action level for at least 30 days.

(d) As medically appropriate for any employee exposed during an emergency.

(e) As soon as possible upon notification by an employee that:

(1) Employee has developed signs or symptoms of possible overexposure to EtO.

(2) Employee desires medical advice concerning effects of current or past exposure to EtO on employee's ability to produce a healthy child.

(f) Specific schedule recommended by the examining physician. (i)(2)(i)

Content (i)(2)(ii)

(a) Medical examinations shall include:

(1) A medical and work history with particular emphasis to symptoms related to pulmonary, hemotologic, neurologic, and reproductive systems, and to eyes and skin.

(2) A physical examination with particular emphasis on symptoms listed above.

(3) A complete blood count to include at least a white cell count, red cell count, hematocrit, and hemoglobin.

(4) Any laboratory or other tests deemed necessary by examining physician. (i)(2)(ii)(a)

(b) Content of medical examination or consulting made available pursuant to (i)(2)(i)(e), shall be determined by the examining physician.

It shall include pregnancy testing or laboratory evaluation of fertility, if requested by the employee and deemed appropriate by the physician.

Information Provided to the Physician (i)(3)

The employer shall provide to examining physician:

(i) A copy of this standard and Appendices A, B and C;

(ii) A description of affected employee's duties as they relate to employee's exposure to EtO;

(iii) Representative level or anticipated level of exposure;

(iv) Description of personal protective and respiratory equipment used or to be used;

(v) Previous medical information of affected employee not otherwise available to examining physician.

Physicians Written Opinion (i)(4)

(i) The employer shall obtain a written opinion of results of the medical examination from the examining physician which is to include:

(a) The physician's opinion whether the employee has any detected medical condition that would place employee at increased risk of material health impairment from exposure to EtO. (i)(4)(i)(a)

(b) Any recommended limitation on employee, or on use of personal protective clothing or equipment, such as respirators. (i)(4)(i)(b)

(c) A statement that employee has been informed by the physician of results of the medical examination, and of any conditions resulting from EtO exposure that require further explanation or treatment. (i)(4)(i)(c)

The employer shall instruct the physician *not* to reveal in the written opinion given to the employer specific finding's or diagnosis unrelated to occupational EtO exposure. (i)(4)(ii)

A copy of the physician's written opinion shall be provided to the affected employee within 15 days of its receipt. (i)(4)(iii)

YES	NO

(j) Communication of EtO Hazards to Employees

Signs and Labels: (j)(1)

Regulated areas and entrances or accessways to regulated areas shall have legible signs demarcating the areas, that bear the following legend:

DANGER
ETHYLENE OXIDE
CANCER HAZARD AND REPRODUCTIVE HAZARD

—

AUTHORIZED PERSONNEL ONLY

—

RESPIRATORS AND PROTECTIVE CLOTHING
MAY BE REQUIRED TO BE WORN
IN THIS AREA (j)(1)(i)

Precautionary labels shall be affixed to all containers of EtO whose contents could cause employee exposure at or above the action level, and (j)(1)(ii)

The labels are to remain affixed when the containers of EtO leave the workplace. (j)(1)(ii)

NOTE: For purpose of this paragraph, reaction vessels, storage tanks, and pipes or piping systems are not considered to be containers.

The labels shall comply with the requirements of 29 CFR 1910.1200 (f) of the Hazard Communication Standard, and to include the following legend:

(a) CAUTION
CONTAINS ETHYLENE OXIDE
CANCER AND REPRODUCTIVE HAZARD

Material Safety Data Sheets (j)(2)

Manufacturers and/or importers of EtO shall comply with the requirements for development of Material Safety Data Sheets (MSDS) as specified in 1910.1200(g). (j)(2)

Information and Training (j)(3)

(i) Information and training shall be provided to employees who are potentially exposed to EtO at or above the action level.

Employees are to receive this information and training at time of initial assignment and at least annually thereafter. (j)(3)(i)

(ii) Employees shall be informed of:

(a) Requirements of this section, an explanation of its contents, including Appendices A and B;

(b) Operations in their work area where EtO is present;

(c) Location and availability of the final EtO rule;*

(d) The medical surveillance program as required by paragraph (i), with an explanation of information in Appendix C.

(iii) Employee training shall include at least:

(a) Methods and observations that may be used to detect presence or release of EtO in work area, such as monitoring procedures monitoring devices;

(b) Physical and health hazards of EtO;

* A copy of the EtO rule 29 CFR 1910.1047 can be obtained from any area or regional OSHA office.

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YES	NO

(c) Protective measures employee can take, including:

— work practices
— emergency procedures
— personal protective equipment to be used;

(d) Details of the hazard communication standard developed by employer, including explanation of:

— the labeling system
— how to obtain and use appropriate hazard information.

(k) Recordkeeping

Objective Data for Exempted Operations (k)(1)(i)

Accurate records shall be maintained of data to support claims of exemption from requirements of this section under paragraph (a)(2), or

Objective data relied on in lieu of initial monitoring under section (d)(2)(ii).

This record shall include at least the following: (k)(1)(ii)

(a) Product qualifying for exemption;

(b) Source of objective data;

(c) Testing protocol, results of testing and/or analysis of material for release of EtO;

(d) Description of operation claimed to be exempted, and how data supports exemption;

(e) Other data relevant to the operations, materials, processing, or exposures covered by the exemption.

Records are to be maintained for duration of employer's reliance upon such data. (k)(1)(iii)

Exposure Measurements (k)(2)

An accurate record shall be kept of all measurements taken to monitor employee exposure to EtO. (k)(2)(i)

The record shall include at least: (k)(2)(ii)

(a) Date of measurement;

(b) Operation being monitored;

(c) Sampling and analytical methods used and evidence of accuracy;

(d) Number, duration, results of samples taken;

(e) Type of protective devices worn;

(f) Name, social security number and exposure of employee(s) whose exposures are represented.

Record shall be maintained for at least thirty (30) years. (k)(2)(iii)

Medical Surveillance (k)(3)

An accurate record of the medical surveillance shall be maintained for each employee subject to medical surveillance. (k)(3)(i)

The record shall include at least the following information: (k)(3)(ii)

(a) Name and social security number;

(b) Physician's written opinion;

(c) Employee medical complaints related to exposure to EtO;

(d) A copy of information provided to physician. (k)(3)(ii)

N1

	YES	NO
The record shall be maintained for duration of employment plus thirty (30) years. **(k)(3)(iii)**		
Availability of Records **(k)(4)**		
Upon written request, all records required to be maintained by this section shall be made available to the Assistant Secretary and the Director of examining and copying. **(k)(4)(i)**		
Upon written request from affected employees, former employees, designated employee representatives, and the Assistant Secretary, the employer shall make available for examination and copying any exemption and exposure records required by (k)(1) and (k)(2) of this section. **(k)(4)(ii)**		
Employee medical records required by paragraph (k)(3) shall be made available for examination and copying, upon wirtten request, to the subject employee, anyone having specific written consent of the subject employee, and the Assistant Secretary. **(k)(4)(iii)**		
Transfer of Records **(k)(5)**		
The employer shall comply with requirements for transfer of records set forth in 29 CFR 1910.20(h). **(k)(5)(i)**		
Whenever employer ceases to do business and there is no successor to receive and maintain records for the prescribed period the employer shall arrange to transmit the records to the Director (of NIOSH). The Director is to be notified ninety (90) days in advance of disposal (transmission of records being transferred). **(k)(5)(ii)**		
(l) Observation of Monitoring		
Employee Observation **(l)(1)**		
Affected employees or their designated representatives shall be provided an opportunity to observe any monitoring of exposure to EtO conducted in accordance with paragraph (d) of this section. **(l)(1)**		

	YES	NO
Observation Procedure **(l)(2)**		
When observation of monitoring requires entry into an area where use of protective clothing or equipment is required, the observer shall be provided such clothing and equipment. **(l)(2)**		
The observer shall comply with all other applicable safety and health procedures. **(l)(2)**		
(m) Dates		
Effective Date: **(m)(1)**		
August 21, 1984, except: Effective date for paragraphs (a)(2), (d), (e), (f)(2), (g)(3), (h), (i), and (j) is March 12, 1985.		
Start-up Dates: **(m)(2)**		
Requirements of paragraphs (c) through (l), (except as noted, but including feasible work practice controls) shall be complied with within 180 days after effective date of this section (by February 19, 1985). Recordkeeping and information collection requirements, paragraphs (a)(2), (d), (e), (f)(2), (g)(3), (h), (i), and (j), must be complied with by September 9, 1985. **(m)(2)(i)**		
Engineering controls specified by paragraph (f)(1) of this section shall be implemented within one (1) year after the effective date. **(m)(2)(ii)**		
(n) Appendices		
Information in appendices is not intended to create any additional obligations or to detract from any existing obligations.		

1910.1048 — FORMALDEHYDE

YES	NO

Scope and Application

This standard applies to all occupational exposures for formaldehyde gas, its solution, and materials that release formaldehyde. **(a)**

Definitions

See page Z-iv. **(b)**

Permissible Exposure Limit (PEL)

Has the employer assured that employees are not exposed to an airborne concentration of formaldehyde which exceeds 0.75 parts formaldehyde per millions parts of air (0.75) as an 8-hour TWA?

Short Term Exposure Level (STEL)

Employees are not exposed to airborne concentrations of formaldehyde which exceed two parts formaldehyde per million parts of air (2 ppm) as a 15-minute STEL. **(c)(2)**

Exposure Monitoring

Are all employees exposed to formaldehyde monitored to determine their exposure level? **(d)(1)(i)**

[**Exceptions:** Employers will not be required to measure exposure to formaldehyde if they can document, using objective data, that the presence of formaldehyde or formaldehyde releasing products in the workplace cannot result in airborne concentrations of formaldehyde that would cause any employee to be exposed at or above the action level or the STEL under forseeable conditions of use.]

When an employee's exposure is determined from the representative sampling, are the measurements used representative of the employee's full shift or short-term exposure to formaldehyde? **(d)(1)(iii)**

Are representative samples for each job classification in each work area taken for each shift, unless it can be documented with objective data that exposure levels for a given job classification are equivalent for different work shifts? **(d)(1)(iv)**

Initial Monitoring

Are employees who may be exposed at or above the action level or above the STEL all identified? **(d)(2)**

Unless the exposure of each employee is measured, is a representative sampling strategy developed? **(d)(2)(i)**

Have sufficient exposures been measured within each job classification for each work shift? **(d)(2)(ii)**

Has the employer promptly monitored the affected employee's exposure upon receiving reports of signs or symptoms of respiratory or dermal conditions associated with formaldehyde exposure? **(d)(2)(iii)**

Periodic Monitoring

Is periodic monitoring conducted to accurately determine exposure when initial monitoring shows that employees are exposed at or above the STEL? **(d)(3)(i)**

If monitoring reveals exposure to be at or above the action level, is monitoring repeated at least every six months? **(d)(3)(ii)**

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YES	NO

If monitoring reveals exposure to be above the STEL, is monitoring repeated at least once a year under the worst conditions? **(d)(3)(iii)**

[**Note:** Periodic monitoring can be discontinued if two consecutive samplings, that are taken at least seven days apart, show that exposure is below the action level and the STEL.] **(d)(4)**

Accuracy of Monitoring

Is monitoring accurate (at least 95% confidence level) to within plus or minus 25% for airborne concentrations at the TWA and STEL, and within plus or minus 35% for airborne concentrations at the action level? **(d)(5)**

Employee Notification

Are affected employees notified of the results of the monitoring within 15 days of determining the results? **(d)(6)**

Is the notification in writing?

If exposure is over the PEL, has a written plan to reduce exposure to below the PEL been developed and employees notified in writing?

Are employees or their representatives permitted to observe any monitoring of exposure? **(d)(7)(i)**

Is the observer provided with the necessary protective clothing? **(d)(7)(ii)**

Regulated Areas

Regulated areas are established where the concentration of formaldehyde exceeds the TWA or STEL, and all entrances and access ways are posted with the following information: **(e)(1)**

DANGER
FORMALDEHYDE
IRRITANT AND POTENTIAL CANCER HAZARD
AUTHORIZED PERSONNEL ONLY

Is access to regulated areas limited to authorized persons who have been trained to recognize the dangers of formaldehyde? **(e)(2)**

Are the access restrictions and location of these regulated areas communicated to other workers who have operations at that work site? **(e)(3)**

Methods of Compliance

Are engineering controls and work practices instituted to reduce and maintain exposures at or below TWA and STEL? **(f)(1)**

[**Note:** If it has been established that engineering controls and work practices cannot reduce exposure, appropriate respirators must be provided that satisfy this standard.]

Respiratory Protection

When respirator protection is required, are employees provided with respirators at no cost? **(g)(1)**

Do the respirators meet the requirements of this standard and reduce the concentration of formaldehyde at or below the TWA or STEL?

Are respirators used in the following circumstances:

YES | NO

During the time needed to install engineering controls;

In work operations, such as maintenance and repair, where engineering controls and work practices are not feasible;

Where engineering controls and work practices do not reduce PELs; and

in emergencies? (g)(1)(i-iii)

Respiratory Selection

Are respirators specified in Table 1 selected from those approved by the Mine Safety and Health Administration (MSHA) and by the National Institute for Occupational Safety and Health (NIOSH) under the provisions of 30 CFR part 11?

(See page 5-31, under Yellow Tab "Safety Programs," for more information on respirator protection.)

Table 1 — Minimum Requirements for Respiratory Protection Against Formaldehyde

Condition of use or formaldehyde concentration (ppm)	Minimum respirator required[1]
Up to 7.5 ppm (10 x PEL).	Full facepiece with cartridges or canisters specifically approved for protection against formaldehyde.[2]
Up to 75 ppm (100 x PEL).	Full-face mask with chin style or chest or back mounted type with industrial size canister specifically approved for protection against formaldehyde. Type C supplied-air respirator, pressure demand or continuous flow type, with full facepiece, head, or helmet.
Above 75 ppm or unknown (emergencies) (100 x PEL).	Self-contained breathing apparatus (SCBA) with positive pressure full facepiece.
22	Combination supplied-air, full facepiece positive pressure respirator with auxiliary self-contained air supply.
Firefighting	SCBA with positive pressure in full facepiece.
Escape	SCBA in demand or pressure demand mode. Full-face mask with chin style or front or back mounted type industrial size canister specifically approved for protection against formaldehyde.

[1] Respirators specified for use at higher concentrations may be used at lower concentrations.

[2] A half-mask respirator with cartridges specifically approved for protection against formaldehyde can be substituted for the full facepiece respirator providing that effective gas-proof goggles are provided and used in combination with the half-mask respirator.

YES | NO

Is a powered air-purifying respirator provided to any employee who experiences difficulty in wearing a negative pressure respirator? (g)(2)(ii)

Respirator Usage

Whenever a respirator is required, is a respiratory protection program established in accordance with 1910.134 (b),(d),(e), and (f)? (g)(3)(i)

At the time of initial fitting and at least annually thereafter, for all employees required to wear negative pressure respirators, has a quantitative or qualitative face fit test been performed in accordance with procedures outlined in Appendix E (see page Z-App-144)? (g)(3)(ii)

Are respirators which provide the best fit selected? (g)(3)(A)

No respirator is chosen that could allow an employee to inhale formaldehyde at concentrations in excess of either the TWA or STEL. (g)(3)(B)

When air-purifying chemical respirators are used, are the cartridges replaced after three hours of use or at the end of the workshift, whichever is sooner? (g)(iii)

(**Note:** Unless the canister contains a NIOSH-approved end-of-service-life indicator to show when breakthrough occurs, canisters used in atmospheres up to 7.5 ppm shall be replaced every 4 hours and industrial sized canisters used in atmospheres up to 75 ppm replaced every two hours or at the end of the workshift, whichever is sooner.) (g)(iv)

Are employees permitted to leave the work areas to wash their facepieces as needed to prevent skin irritation? (g)(v)

Protective Equipment and Clothing

Are standards 1910.132 and 133 complied with in regard to protective gear? (h)

Are employees supplied with protective equipment at no cost?

Is protective clothing selected based on the form of formaldehyde, the conditions of use, and the potential hazards? (h)(1)

Is all eye and skin contact with liquids containing 1 percent formaldehyde prevented with the use of protective clothing and equipment? (h)(i)

Is all contact with irritating materials prevented? (h)(ii)

Are chemical safety goggles required if there is a chance that formaldehyde could reach the eye area? (h)(iii)

Where concentrations are unknown or exceed 100 ppm, is full-body protection worn? (h)(iv)

Is contaminated equipment or clothing cleaned or laundered before it is reused? (h)(2)(i)

Is a storage area used when ventilating contaminated equipment and clothing?

Is the storage area labeled with the following information?

DANGER
FORMALDEHYDE-CONTAMINATED EQUIPMENT
AVOID INHALATION AND SKIN CONTACT

Are only persons trained in the hazards of formaldehyde allowed to remove the contaminated material from the storage area? (h)(2)(iii)

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	YES	NO
Are employees prohibited from taking any equipment or clothing home which has been contaminated with formaldehyde? (h)(2)(iv)		
Is protective equipment replaced when necessary to assure its effectiveness? (h)(2)(v)		
Is the person who launders contaminated clothing warned of the potentially harmful effect of formaldehyde? (h)(2)(vi)		
Hygiene Protection		
Are change rooms provided (described in 1910.141) for employees who are required to change into protective clothing? (i)(1)		
Are drench showers installed if an employee's skin could be splashed with liquids containing 1 percent or more formaldehyde? (i)(2)		
If there is a chance that an employee's eyes could be splashed with solution containing 0.1 percent or greater formaldehyde, are eyewash facilities installed within the immediate work area? (i)(3)		
Housekeeping		
Are regular housekeeping programs conducted to detect leaks and spills, including visual inspections? (j)		
Is preventive maintenance of equipment regularly undertaken? (j)(1)		
If spillage could occur, are there provisions to contain the spill, to decontaminate the area, and to dispose of the waste? (j)(2)		
Are all leaks and spills cleaned up promptly by employees wearing suitable protective clothing and trained in the proper methods for cleanup and decontamination? (j)(3)		
Is waste contaminated with formaldehyde placed for disposal in sealed containers bearing a warning label that states the hazards of formaldehyde? (j)(4)		
Emergencies		
In the event of an emergency, are the appropriate procedures undertaken in order to minimize injury or loss of life? (k)		
Medical Surveillance		
Is a medical surveillance program instituted for all employees exposed to concentrations above or at the action level? (l)(1)(i)		
Is medical surveillance available to all employees who show signs of overexposure to formaldehyde and for all employees exposed during emergencies? (l)(1)(ii)		
[**Note:** When determining whether an employee is showing signs of overexposure, the employer can rely on the evidence that signs associated with formaldehyde exposure will occur only in exceptional circumstances when airborne exposure is less than 0.1 ppm and when formaldehyde is present in materials in concentrations less than 0.1 percent.]		
Are all medical procedures performed by or under the supervision of a licensed physician, and at no cost to the employee? (l)(2)		

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	YES	NO
Medical Disease Questionnaire		
Is medical surveillance available to employees annually before they are assigned work where formaldehyde is present, or when exposure is at or above the action level? (l)(3)		
If an employee is showing signs indicative of overexposure to formaldehyde, is a medical disease questionnaire (such as the one in Appendix D, page Z-App-142) administered? (l)(3)(i)		
Based on an evaluation of the questionnaire, does a physician determine whether a medical examination is necessary for employees who are not required to wear respirators? (l)(3)(ii)		
Medical Examinations		
Are medical examinations given to any employee who the physician feels may be at an increased risk from exposure to formaldehyde, at the time of initial assignment, and at least annually thereafter to all employees required to wear a respirator to reduce exposure? (l)(4)		
Does the examination include the following:		
A physical examination with emphasis on the skin and respiratory system, shortness of breath, or irritation of the eyes;		
Laboratory examination for respirator wearers consisting of baseline and annual pulmonary function tests;		
Any other test which the physician deems necessary to complete the written opinion; and		
Counseling of employees having medical conditions that would be directly or indirectly aggravated by exposure? (l)(4)(i-v)		
Is a medical examination immediately available to all employees who have been exposed to formaldehyde during an emergency? (l)(5)		
Does the examination include a medical and work history with emphasis on any evidence of upper or lower respiratory problems, allergic conditions, skin reactions or hypersensitivity, and any evidence of eye, nose, and throat irritation? (l)(5)(i)		
Has the following information been provided to the physician:		
A copy of this standard and its appendices;		
A description of the affected employee's job duties, as they relate to formaldehyde exposure;		
The representative exposure level for the employee's job assignment;		
Information regarding any personal protective equipment and respiratory equipment used by the employee; and		
Information for previous medical examinations regarding the affected employee? (l)(6)(i-v)		
In cases of an emergency, is the physician given a description of how the emergency occurred and how much exposure the victim may have received?		
Is a written opinion obtained from the examining physician? (l)(7)		
Does the written opinion contain the results of the medical examination? (It shall not reveal specific findings or diagnoses unrelated to occupation exposure to formaldehyde.) (l)(7)(i)		

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	YES	NO
Does the opinion contain the following:		
The physician's opinion as to whether the employee has any medical condition that would place him or her at an increased risk of material impairment of health from exposure to formaldehyde;		
Any recommended limitations on the employee's exposure or changes in the use of personal protective equipment; and		
A statement that the employee has been informed by the physician of any medical condition which would be aggravated by exposure to formaldehyde? **(I)(7)(A-C)**		
Is a way to retain the medical records provided? **(I)(7)(ii)**		
Is a copy of the written opinion supplied to the employee within 15 days of its receipt? **(I)(7)(iii)**		
Medical Removal		
[**Note:** The provisions of paragraph (I)(8) apply when an employee reports significant irritation of the mucosa of the eyes or of the upper airways, respiratory sensitization, dermal irritation or dermal sensitization attributed to workplace formaldehyde exposure. Medical removal provisions do not apply in the case of dermal irritation or dermal sensitization when the product suspected of causing the dermal condition contains less than 0.05% formaldehyde.] **(I)(8)(i)**		
Is an employee's report of signs or symptoms of possible overexposure to formaldehyde evaluated by a doctor selected by the employer pursuant to paragraph (I)(3)? **(I)(8)(ii)**		
If the physician determines that a medical examination is not necessary under paragraph (I)(3)(ii), has the employer allowed for a two-week evaluation period to ascertain whether the employee's signs or symptoms subside untreated or with the use of creams, gloves, first aid treatment or personal protective equipment? **(I)(8)(ii)**		
Has the employer implemented industrial hygiene measures that limit the employee's exposure to formaldehyde during this period? **(I)(8)(ii)**		
Has the employee been immediately referred to a physician prior to expiration of the two-week period if the signs or symptoms worsen? **(I)(8)(ii)**		
[**Note:** Earnings, seniority and benefits may not be altered during the two-week period by virtue of the report.] **(I)(8)(ii)**		
If the signs or symptoms have not subsided or been remedied by the end of the two-week period, or earlier if signs or symptoms warrant, has the employer selected a physician to examine the employee? **(I)(8)(iii)**		
Has the physician presumed, in the absence of contrary evidence, that observed dermal irritation or dermal sensitization are not attributable to formaldehyde when products to which the effected employee is exposed contain less than 0.1% formaldehyde? **(I)(8)(iii)**		
Are medical examinations conducted in compliance with the requirements of paragraph (I)(5)(i) and (ii)? **(I)(8)(iv)**		
If the physician finds that significant irritation of the mucosa of the eyes or of the upper airways, respiratory sensitization, dermal irritation, or dermal sensitization result from workplace formaldehyde exposure and recommends restrictions or removal, does the employer promptly comply with the recommendations? **(I)(8)(v)**		

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	YES	NO
In the event of a recommendation of a removal, has the employer removed the affected employee from the current formaldehyde exposure and if possible, transferred the employee to work having significantly less exposure to formaldehyde? **(I)(8)(v)**		
When an employee is removed pursuant to paragraph (I)(8)(v), has the employer transferred the employee to comparable work for which:		
The employee is qualified or can be trained in less than six months;		
Where the formaldehyde exposures are as low as possible, but not higher than the action level?		
Does the employer maintain the employee's current earnings, seniority, and other benefits? **(I)(8)(vi)**		
If there is no such work available, does the employer maintain the employee's current earnings, seniority and other benefits until:		
Such work becomes available;		
Until the employee is determined to be unable to return to workplace formaldehyde exposure;		
Until the employee is determined to be able to return to the original job status, or for six months, whichever comes first? **(I)(8)(vi)**		
Does the employer arrange for a follow-up medical examination to take place within six months after the employee is removed pursuant to this paragraph? **(I)(8)(vii)**		
Does this examination determine if the employee can return to the orignal job status or if the removal is to be permanant? **(I)(8)(vii)**		
Does the physician make a decision within six months of the date the employee was removed as to whether the employee can be returned to the original job status, or if the removal is to be permanant? **(I)(8)(vii)**		
Does an employer's obligation to provide earnings, seniority and other benefits to a removed employee, reduced to the extent that the employee receives compensation for earnings lost during the period of removal, either from a publicly or employer-funded compensation program or from employment with another employer made possible by the virtue of the employee's removal? **(I)(8)(viii)**		
Does the employer rely on objective data in making determinations of the formaldehyde content of materials under this paragraph? **(I)(8)(ix)**		
Multiple Physician Review		
After the employer selects the initial physician who conducts any medical examination or consultation to determine whether medical removal or restriction is appropriate, does the employer allow the employee to designate a second physician to:		
Review any findings, determinations or recommendations of the intitial physicians;		
To conduct such examinations, consultations, and laboratory tests in order to evaluate the effects of formaldehyde exposure;		
To facilitate this review? **(I)(9)(i)**		

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	YES	NO
Does the employer promptly notify an employee of the right to seek a second medical opinion after each occasion that an initial physician conducts a medical or consultation for the purpose of medical removal or restriction? **(l)(9)(ii)**		
[**Note:** The employer may condition its participation in, and payment for, the multiple physician review mechanism upon the employee doing the following within 15 days after receipt of the notification of the right to seek a medical opinion or receipt of the initial physician's written opinion, whichever is later; **(l)(9)(iii)**		
The employee informs the employer of the intention to seek a second medical opinion; **(l)(9)(iii)(A)**		
The employee initiates steps to make an appointment with a second physician.] **(l)(9)(iii)(B)**		
If the findings, determinations or recommendations of the second physician differ from those of the initial physician, does the employer and the employee assure that efforts are made between the two physicians to resolve the disagreement? **(l)(9)(iv)**		
If the two physicians are unable to quickly resolve their disagreement, does the employer and the employee through their respective physicians designate a third physician? **(l)(9)(iv)**		
Is the third physician a specialist in the field of issue who is qualified to:		
Review the findings, determinations or recommendations of the prior physicians; and		
To conduct such examinations, consultations, laboratory tests and discussions with the prior physicians as the third physician deems necessary to resolve the disagreement of the prior physicians? **(l)(9)(iv)(A-B)**		
In the alternative, does the employer and the employee or authorized employee representative jointly designate such third physician? **(l)(9)(v)**		
Does the employer act consistent with the findings, determinations and recommendations of the third physician, unless the employer and the employee reach an agreement which is otherwise consistent with the recommendations of at least one of the three physicians? **(l)(9)(vi)**		
Hazard Communication		
Communication of the hazards associated with formaldehyde in the workplace shall be governed by the requirements of paragraph (m). The definitions of 1910.1200(c) shall apply under this paragraph.		
Are the following subject to the hazard communication requirements of this paragraph; formaldehyde gas, all mixtures or solutions composed of greater than 0.1 percent formaldehyde and materials capable of releasing formaldehyde into the air, under reasonably forseeable conditions of use, at concentrations reaching or exceeding 0.1 ppm? **(m)(1)(i)**		
Does the employer address, as a minimum, the following specific health hazards: cancer, irritation and sensitization of the skin and respiratory system, eye and throat irritation, and acute toxicity? **(m)(1)(ii)**		
Do manufacturers and importers who produce or import formaldehyde supply the required Material Safety Data Sheets? **(m)(2)**		

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	YES	NO
Labels		
Does the employer assure that hazard warning labels complying with the requirements of 1910.1200(f) are affixed to all containers of materials listed in paragraph (m)(1)(1), except to the extent that 1910.1200(f) is inconsistent with this paragraph? **(m)(3)(i)**		
Do labels for all materials listed in paragraph (m)(1)(i) capable of releasing formaldehyde at levels of 0.1 ppm to 0.5 ppm include the following information:		
That the products contain formaldehyde;		
The name and address of the responsible party;		
A statement that physical and health hazard information is readily available from the employer and from MSDSs? **(m)(3)(ii)**		
Do labels for materials listed in paragraph (m)(1)(i) capable of releasing formaldehyde at levels above 0.5 ppm address all hazards pertaining to 1910.1200(d), 1910.1200 appendices A and B, including respiratory sensitization? **(m)(3)(iii)**		
Do labels for materials listed in (m)(1)(i) contain the words "Potential Cancer Hazard"? **(m)(3)(iii)**		
In making the determinations of anticipated levels of formaldehyde release, has the employer relied on objective data indicating the extent of potential formaldehyde release under the reasonably forseeable conditions of use? **(m)(3)(iv)**		
The employer may use warning labels required by other statutes, regulations or ordinances which impart the same information as the warning statements required by this paragraph. **(m)(3)(v)**		
Material Safety Data Sheets		
Are the requirements of 1910.1200(g) complied with in regard to formaldehyde? **(m)(4)(i)**		
Do all manufacturers, importers and distributers of formaldehyde-containing materials provide MSDSs and updated information to all employers purchasing such materials at the time of the initial shipment and at the time of the first shipment after a MSDS is updated? **(m)(4)(ii)**		
Written Hazard Communication Program		
Has the employer developed, implemented and maintained at the workplace, a written hazard communication program for formaldehyde exposures, which at a minimum describes how the requirements pertaining to labels and other forms of warning, MSDSs and employee information and training will be met? **(m)(5)**		
Have employers in multi-employer workplaces complied with the requirements of 1910.1200(e)(2)? **(m)(5)**		
Employee Information and Training		
Employers are exempt from meeting employee training requirements if they can show, using objective data, that employees are not exposed to formaldehyde at or above 0.1 ppm. **(n)(1)**		
Are employees provided with information and training on formaldehyde at the time of their initial assignment and whenever a new exposure from formaldehyde is introduced into their work area? **(n)(2)**		
Is such information and training provided at least annually?		

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	YES	NO
Is the training program conducted in a manner which the employee can understand? **(n)(3)**		
Does the training program discuss the following:		
The contents of the Material Safety Data Sheet;		
The purpose and description of the medical surveillance program, including a description of the potential health hazards associated with formaldehyde;		
A description of the signs and symptoms of exposure;		
Instructions to immediately report the development of any adverse signs that the employee suspects could be due to formaldehyde exposure;		
A description of operations in the work areas where formaldehyde is present and an explanation of the safe work practices appropriate for limiting exposure to formaldehyde in each job;		
The purpose for, proper use of, and limitations of personal protective clothing and equipment;		
Instructions for handling of spills, emergencies, and clean-up procedures;		
An explanation of the importance of engineering and work practice control for employee protection and any necessary instructions in the use of these controls; and		
A review of emergency procedures including the specific duties or assignments of each employee in the event of an emergency. **(n)(3)(i-vii)**		
Are all affected employees informed of the location of written training material? **(n)(4)**		
Upon request, are all training materials related to the employee training programs provided to the Assistant Secretary and to the Director?		
Recordkeeping		
Are accurate records kept of all measurements taken to monitor employee exposure to formaldehyde? **(o)(1)**		
Do the records include the following:		
The date of measurement;		
The operation being monitored;		
The methods of sampling and analysis and evidence of their accuracy;		
The number, duration, time, and results of samples taken;		
The types of protective devices worn; and		
The names, job classification, social security number, and exposure estimates of the employees whose exposures are represented by the actual monitoring results.		
Where it has been determined that no monitoring is needed, is a record maintained of the objective data relied upon to support that determination? **(o)(2)**		

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	YES	NO
Are accurate records kept for each employee subject to medical surveillance? **(o)(3)**		
Do the records contain the following:		
The name and social security number of the employee;		
The physician's written opinion;		
A list of any employee health complaints; and		
A copy of the medical examination. **(o)(3)(i-v)**		
Are accurate records maintained for employees subject to negative pressure respirator fit testing? **(o)(4)**		
Do the records contain the following:		
A copy of the protocol selected for the respirator fit testing;		
A copy of the result of any fit testing performed;		
The size of and manufacturer of the types of respirators available for selection; and		
The date of the most recent fit testing, the name and social security number of each tested employee, and the respirator type and facepiece selected.		
Are exposure records maintained for at least 30 years? **(o)(5)**		
Are medical records kept for the duration of employment plus 30 years?		
Are records of respirator fit testing kept until replaced by a more recent record?		
Upon request, are exposure records made available for examination or copying to the subject employee, or former employee, and employee representative, in accordance with 1910.20 (a) thru (e) and (g) thru (f)?		
Dates		
Respiratory protection requirements to meet the amended PEL of 0.75 ppm must be provided as soon as possible but no later than September 24, 1992. **(p)(3)(i)**		
Engineering and work practice controls required to meet the amended PEL of 0.75 ppm TWA shall be implemented no later than June 26, 1993. **(p)(3)(ii)**		
The medical removal protection provisions including the multiple physician review mechanism must be implemented no later than December 28, 1992. **(p)(3)(iii)**		
The labeling provisions contained in amended paragraph (m) of this standard must be implemented no later than December 28, 1992. Labeling of containers of formaldehyde products must continue to comply with the provisions of 1910.1200(e)-(j) until that time. **(p)(3)(iv)**		
The periodic training mandated for all employees exposed to formaldehyde between 0.1 ppm and 0.5 ppm shall begin no later than August 25, 1992. **(p)(3)(v)**		

(The appendices for 1910.1048 begin on page Z-App-133.)

[1910. 1048 (p)(2)(vi) added by 53 FR 6629, 3/2/88.],

1910.1050 — Methylenedianiline

	YES	NO

(a) Scope and Application

This section applies to all occupational exposures to MDA, Chemical Abstracts Service Registry No. 101-77-9, except as provided in paragraphs (a)(2) through (a)(7) of this section. **(a)**

Except as provided in paragraphs (a)(8) and (e)(5) of this section, this section does not apply to the processing, use, and handling of products containing MDA where initial monitoring indicates that the product is not capable of releasing MDA in excess of the action level under the expected conditions of processing, use, and handling which will cause the greatest possible release; and where no "dermal exposure to MDA" can occur. **(a)(2)**

Except as provided in paragraphs (a)(8) and (e)(5) of this section, this section does not apply to the processing, use, and handling of products containing MDA where objective data are reasonably relied upon which demonstrate the product is not capable of releasing MDA under the expected condition of processing, use and handling which will cause the greatest possible release; and where no "dermal exposure to MDA" can occur. **(a)(3)**

This section does not apply to the storage, transportation, distribution or sale of MDA in intact containers sealed in such a manner as to contain the MDA dusts, vapors, or liquids, except for the provisions of 29 CFR 1910.1200 and paragraph (d) of this section. **(a)(4)**

This section does not apply to the construction industry as defined in 29 CFR 1910.12(b). (Exposure to MDA in the construction industry is covered by 29 CFR 1926.60) **(a)(5)**

Except as provided in paragraph (a)(8) of this section, this section does not apply to materials in any form which contain less then 0.1% MDA by weight or volume. **(a)(6)**

Except as provided in paragraph (a)(8) of this section, this section does not apply to "finished articles containing MDA." **(a)(7)**

Where products containing MDA are exempted under paragraphs (a)(2) through (a)(7) of this section, does the employer maintain records of the initial monitoring results or objective data supporting that exemption and the basis for the employer's reliance on the data, as provided in the record keeping provision of paragraph (n) of this section? **(a)(8)**

(b) Definitions

See page Z-v

(c) Permissible Exposure Limits (PEL)

Does the employer assure that no employee is exposed to an airborne concentration of MDA in excess of ten parts per billion (10 ppb) as an 8-hour time-weighted average or a STEL of 100 ppb? **(c)**

(d) Emergency Situations

Written Plan

Is a written plan for emergency situations developed for each workplace where there is a possibility of an emergency?

Are appropriate portions of the plan implemented in the event of an emergency? **(d)(1)(i)**

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	YES	NO

Does the plan specifically provide that employees engaged in correcting emergency conditions be equipped with the appropriate personal protective equipment and clothing as required in paragraphs (h) and (i) of this section until the emergency is abated? **(d)(1)(ii)**

Does the plan specifically include provisions for alerting and evacuating affected employees as well as the elements prescribed in 29 CFR 1910.38, "Employee emergency plans and fire prevention plans?" **(d)(1)(iii)**

Alerting Employees

Where there is the possibility of employee exposure to MDA due to an emergency, are means developed to alert promptly those employees who have the potential to be directly exposed? **(d)(2)**

Are affected employees not engaged in correcting emergency conditions evacuated immediately in the event that an emergency occurs. **(d)(2)**

Are means also developed and implemented for alerting other employees who may be exposed as a result of the emergency? **(d)(2)**

(e) Exposure Monitoring

Are determinations of employee exposure made from breathing zone air samples that are representative of each employee's exposure to airborne MDA over an eight (8) hour period? **(e)(1)(i)**

Is determination of employee exposure to the STEL made from breathing zone air samples collected over a 15 minutes sampling period? **(e)(1)(i)**

Is representative employee exposure determined on the basis of one or more samples representing full shift exposure for each shift for each job classification in each work area where exposure to MDA may occur? **(e)(1)(ii)**

Where the employer can document that exposure levels are equivalent for similar operations in different work shifts, does the employer determine representative employee exposure for that operation during one shift? **(e)(1)(iii)**

Initial Monitoring

Does each employer who has a workplace or work operation covered by this standard perform initial monitoring to determine accurately the airborne concentrations of MDA to which employees may be exposed? **(e)(2)**

Periodic Monitoring and Monitoring Frequency.

If the monitoring required by paragraph (e)(2) of this section reveals employee exposure at or above the action level, but at or below the PELs, does the employer repeat such representative monitoring for each such employee at least every six (6) months? **(e)(3)(i)**

If the monitoring required by paragraph (e)(2) of this section reveals employee exposure above the PELs, does the employer repeat such monitoring for each such employee at least every three (3) months? **(e)(3)(ii)**

YES	NO

Note: The employer may alter the monitoring schedule from every three months to every six months for any employee for whom two consecutive measurements taken at least 7 days apart indicate that the employee exposure has decreased to below the TWA but above the action level. **(e)(3)(iii)**

Termination of Monitoring

If the initial monitoring required by paragraph (e)(2) of this section reveals employee exposure to be below the action level, does the employer discontinue the monitoring for that employee, except as otherwise required by paragraph (e)(5) of this section? **(e)(4)(i)**

Note: If the periodic monitoring required by paragraph (e)(3) of this section reveals that employee exposures, as indicated by at least two consecutive measurements taken at least 7 days apart, are below the action level the employer may discontinue the monitoring for that employee, except as otherwise required by paragraph (e)(5) of this section. **(e)(4)(ii)**

Additional Monitoring

Does the employer institute the exposure monitoring required under paragraphs (e)(2) and (e)(3) of this section when there has been a change in production process, chemicals present, control equipment, personnel, or work practices which may result in new or additional exposures to MDA, or when the employer has any reason to suspect a change which may result in new or additional exposures? **(e)(5)**

Accuracy of Monitoring

Is monitoring accurate, to a confidence level of 95 percent to within plus or minus 25 percent for airborne concentrations of MDA? **(e)(6)**

Employee Notification of Monitoring Results

Within 15 working days after the receipt of the results of any monitoring performed under this standard, does the employer notify each employee of these results, in writing, either individually or by posting of results in an appropriate location that is accessible to affected employees? **(e)(7)(i)**

Does the written notification required by paragraph (e)(7)(i) of this section contain the corrective action being taken by the employer to reduce the employee exposure to or below the PELs, wherever the PELs are exceeded? **(e)(7)(ii)**

Visual Monitoring

Does the employer make routine inspections of employee hands, face, and forearms potentially exposed to MDA? **(e)(8)**

Are other potential dermal exposures reported by the employee referred to the appropriate medical personnel for observation? **(e)(8)**

If the employer determines that the employee has been exposed to MDA does the employer: **(e)(8)(i)**

- Determine the source of exposure; **(e)(8)(i)**
- Implement protective measure to correct the hazard; **(e)(8)(ii)**

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YES	NO

AND

- Maintain records of the corrective actions in accordance with paragraph (n) of this section? **(e)(8)(iii)**

(f) Regulated Areas

Airborne Exposures

Does the employer establish regulated areas where airborne concentrations of MDA exceed or can reasonably be expected to exceed, the permissible exposure limits? **(f)(1)(i)**

Dermal Exposures

Where employees are subject to dermal exposure to MDA does the employer establish those work areas as regulated areas? **(f)(1)(ii)**

Demarcation

Are regulated areas demarcated from the rest of the workplace in a manner that minimizes the number of persons potentially exposed? **(f)(2)**

Access

Is access to regulated areas limited to authorized persons? **(f)(3)**

Personal Protective Equipment

Is each person entering a regulated area supplied with, and required to use, the appropriate personal protective clothing and equipment in accordance with paragraph (h) and (i) of this section? **(f)(4)**

Prohibited Activities

Does the employer ensure that employees do not eat, drink, smoke, chew tobacco or gum, or apply cosmetics in regulated areas? **(f)(5)**

(g) Methods of Compliance

Engineering Controls and Work Practices

Does the employer institute engineering controls and work practices to reduce and maintain employee exposure to MDA at or below the PELs except to the extent that the employer can establish that these controls are not feasible or where the provisions of paragraph (g)(1)(ii) or (h)(1)(i) through (iv) of the section apply? **(g)(1)(i)**

Wherever the feasible engineering controls and work practices which can be instituted are not sufficient to reduce employee exposure to or below the PELs, does the employer use them to reduce employee exposure to the lowest levels achievable by these controls and supplement them by the use of respiratory protective devices which comply with the requirements of paragraph (h) of this section? **(g)(1)(ii)**

Compliance Program

Does the employer establish and implement a written program to reduce employee exposure to or below the PELs by means of engineering and work practice controls, as required by paragraph (g)(1) of this section, and by use of respiratory protection where permitted under this section? **(g)(2)(i)**

	YES	NO
Does the program include a schedule for periodic maintenance (e.g., leak detection) and include the written plan for emergency situations as specified in paragraph (d) of this section? **(g)(2)(i)**		
Is this written program upon request, furnished for examination and copying to the Assistant Secretary, the Director, affected employees, and designated employee representatives? **(g)(2)(ii)**		
Does the employer review and, as necessary, update such plans at least once every 12 months to make certain they reflect the current status of the program? **(g)(2)(ii)**		
Employee Rotation		
Is employee rotation not permitted as a means of reducing exposure? **(g)(3)**		
(h) Respiratory Protection		
General		
Does the employer provide respirators, and ensure that they are used, where required by this section? **(h)(1)**		
Are respirators used in the following circumstances: **(h)(1)**		
• During the time period necessary to install or implement feasible engineering and work practice controls; **(h)(1)(i)**		
• In work operations for which the employer establishes that engineering and work practice controls are not feasible; **(h)(1)(ii)**		
• In work situations where feasible engineering and work practice controls are not yet sufficient to reduce exposure to or below the PEL; **(h)(1)(iii)**		
AND		
• In emergencies? **(h)(1)(iv)**		
Respirator Selection		
Where respirators are required or allowed under this section, does the employer select and provide, at no cost to the employee, the appropriate respirator as specified in Table 1, and assure that the employee uses the respirator provided? **(h)(2)(i)**		
Does the employer select respirators from among those approved by the Mine Safety and Health Administration and the National Institute for Occupational Safety and Health under the provisions of 30 CFR part 11? **(h)(2)(ii)**		
Is any employee who cannot wear a negative pressure respirator given the option of wearing a positive pressure respirator or any supplied-air respirator operated in the continuous flow or pressure demand mode? **(h)(2)(iii)**		
Respirator Program		
Does the employer institute a respiratory protection program in accordance with 29 CFR 1910.134(b), (d), (e), and (f)? **(h)(3)**		

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	YES	NO
Respirator Use		
Where air-purifying respirators (cartridge or canister) are used, does the employer replace the air purifying element as needed to maintain the effectiveness of the respirator? **(h)(4)(i)**		
Does the employer ensure that each cartridge is dated at the beginning of use? **(h)(4)(i)**		
Are employees who wear respirators allowed to:		
• Leave the regulated area to readjust the facepiece;		
• Wash their faces;		
AND		
• Wipe clean the facepieces on their respirators in order to minimize potential skin irritation associated with respirator use? **(h)(4)(ii)**		
Respirator Fit Testing		
Does the employer perform and record the results of either quantitative or qualitative fit tests at the time of initial fitting and at least annually thereafter for each employee wearing a negative pressure respirator? **(h)(5)(i)**		
Is the test used to select a respirator facepiece which provides the required protection as prescribed in Table 1? **(h)(5)(i)**		

Airborne concentration of MDA or condition of use	Respirator type
a. Less than or equal to 10 × PEL	(1) Half-Mask Respirator with HEPA[1] Cartridge.[2]
b. Less than or equal to 50 × PEL	(1) Full facepiece respirator with HEPA[1] Cartridge or Canister.[2]
C. Less than or equal to 1000 × PEL	(1) Full facepiece powered air-purifying respirator with HEPA[1] cartridges.[2]
d. Greater than 1000 × PEL or unknown concentrations	(1) Self-contained breathing apparatus with full facepiece in positive pressure mode.
	(2) Full facepiece positive pressure demand supplied-air respirator with auxiliary self-contained air supply.
e. Escape	(1) Any full facepiece air-purifying respirator with HEPA[1] cartridges.[2]
	(2) Any positive pressure or continuous flow self-contained breathing apparaturs with full facepiece or hood.
f. Firefighting	(1) Full facepiece self-contained breathing apparatus in positive pressure demand mode.

Note: Respirators assigned for higher environmental concentrations may be used at lower concentrations.

[1]High Efficiency Particulate in Air filter (HEPA) means a filter that is at least 99.97 percent efficient against mono-dispered particles of 0.3 micrometers or larger.

[2]Combination HEPA/Organic Vapor Cartridges shall be used whenever MDA in liquid form or a process requiring heat is used.

	YES	NO
Does the employer follow the test protocols outlined in Appendix E of this standard for whichever type of fit testing the employer chooses? (h)(5)(ii)		
(i)Protective Work Clothing and Equipment.		
Provision and Use		
Where employees are subject to dermal exposure to MDA, where liquids containing MDA can be splashed into the eyes, or where airborne concentrations of MDA are in excess of the PEL, does the employer provide, at no cost to the employee, and ensure that the employee uses, appropriate protective work clothing and equipment which prevent contact with MDA such as, but not limited to: (i)(1)		
• Aprons, coveralls or other full-body work clothing; (i)(1)(i)		
• Gloves, head coverings, and foot coverings; (i)(1)(ii)		
• Face shields, chemical goggles; (i)(1)(iii)		
OR		
• Other appropriate protective equipment which comply with 1910.133? (i)(1)(iv)		
Removal and storage		
Does the employer ensure that, at the end of their work shift, employees remove MDA-contaminated protective work clothing and equipment that is not routinely removed throughout the day in change rooms provided in accordance with the provisions established for change rooms? (i)(2)(i)		
Does the employer ensure that, during their work shift, employees remove all other MDA-contaminated protective work clothing or equipment before leaving a regulated area? (i)(2)(ii)		
Does the employer ensure that no employee takes MDA-contaminated work clothing or equipment out of the change room, except those employees authorized to do so for the purpose of laundering, maintenance, or disposal? (i)(2)(iii)		
Are MDA-contaminated work clothing or equipment placed and stored in closed containers which prevent dispersion of the MDA outside the container? (i)(2)(iv)		
Do containers of MDA-contaminated protective work clothing or equipment which are to be taken out of change rooms or the workplace for cleaning, maintenance, or disposal, bear labels warning of the hazards of MDA? (i)(2)(v)		
Cleaning and Replacement		
Does the employer provide the employee with clean protective clothing and equipment? (i)(3)(i)		
Does the employer ensure that protective work clothing or equipment required by this paragraph is cleaned, laundered, repaired, or replaced at intervals appropriate to maintain its effectiveness? (i)(3)(i)		
Does the employer prohibit the removal of MDA from protective work clothing or equipment by blowing, shaking, or any methods which allow MDA to re-enter the workplace? (i)(3)(ii)		
Does the employer ensure that laundering of MDA-contaminated clothing be done so as to prevent the release of MDA in the workplace? (i)(3)(iii)		

	YES	NO
Does any employer who gives MDA-contaminated clothing to another person for laundering inform such person of the requirement to prevent the release of MDA? (i)(3)(iv)		
Does the employer inform any person who launders or cleans protective clothing or equipment contaminated with MDA of the potentially harmful effects of exposure? (i)(3)(v)		
Is MDA-contaminated clothing transported in properly labeled, sealed, impermeable bags or containers? (i)(3)(vi)		
(j) Hygiene Facilities and Practices.		
Change Rooms		
Does the employer provide clean change rooms for employees, who must wear protective clothing, or who must use protective equipment because of their exposure to MDA? (j)(1)(i)		
Are change rooms equipped with separate storage for protective clothing and equipment and for street clothes which prevents MDA contamination of street clothes? (j)(1)(ii)		
Showers		
Does the employer ensure that employees shower at the end of the work shift when they work in areas where there is the potential for exposure resulting from airborne MDA (e.g., particulates or vapors) above the action level? (j)(2)(i)		
Do shower facilities required by this paragraph comply with 1910.141(d)((3)? (j)(2)(i)(A)		
Does the employer ensure that employees who are required to shower pursuant to the provisions contained herein do not leave the workplace wearing any protective clothing or equipment worn during the work shift? (j)(2)(i)(B)		
Where dermal exposure to MDA occurs, does the employer ensure that materials spilled or deposited on the skin are removed as soon as possible by methods which do not facilitate the dermal absorption of MDA? (j)(2)(iii)		
Lunch Facilities		
Availability and Construction		
Whenever food or beverages are consumed at the worksite and employees are exposed to MDA at or above the PEL or are subject to dermal exposure to MDA, does the employer provide readily accessible lunch areas? (j)(3)(i)(A)		
Do lunch areas located within the workplace and in areas where there is the potential for airborne exposure to MDA at or above the PEL have a positive pressure, temperature controlled, filtered air supply? (j)(3)(i)(B)		
Are lunch areas not located in areas within the workplace where the potential for dermal exposure to MDA exists? (j)(3)(i)(C)		
Does the employer ensure that employees who have been subjected to dermal exposure to MDA or who have been exposed to MDA above the PEL wash their hands and faces with soap and water prior to eating, drinking, smoking, or applying cosmetics? (j)(3)(ii)		
Does the employer ensure that employees exposed to MDA do not enter lunch facilities with MDA-contaminated protective work clothing or equipment? (j)(3)(iii)		

YES	NO

(k) Communication of Hazards to Employees

Signs and Labels

Does the employer post and maintain legible signs demarcating regulated areas and entrances or access ways to regulated that bear the following legend:

DANGER MDA MAY CAUSE CANCER
LIVER TOXIN AUTHORIZED PERSONNEL ONLY
RESPIRATORS AND PROTECTIVE CLOTHING MAY BE REQUIRED TO BE WORN IN THIS AREA? **(k)(1)(i)**

Does the employer ensure that labels or other appropriate forms of warning are provided for containers of MDA within the workplace? **(k)(1)(ii)**

Do the labels comply with the requirements of 29 CFR 1910.1200(f) and include the following legends? **(k)(1)(ii)**

For pure MDA:

DANGER CONTAINS MDA
MAY CAUSE CANCER
LIVER TOXIN **(k)(1)(ii)(A)**

For mixtures containing MDA:

DANGER CONTAINS MDA
CONTAINS MATERIALS WHICH MAY CAUSE CANCER
LIVER TOXIN **(k)(1)(ii)(B)**

Material Safety Data Sheets (MSDS)

Does the employer obtain or develop, and provide access to their employees a material safety data sheet (MSDA) for MDA? **(k)(2)(i)**

In meeting this obligation, does the employer make appropriate use of the information found in Appendices A and B? **(k)(2)(i)**

Do employers who are manufacturers or importers:

- Comply with paragraph (k)(1)(ii) of this section as appropriate; **(k)(2)(ii)(A)**

AND

- Comply with the requirement in OSHA's Hazard Communication standard, 29 CFR 1910.1200, that they deliver to downstream employers an MSDS for MDA? **(k)(2)(ii)(B)**

Information and Training

Does the employer provide employees with information and training on MDA, in accordance with 29 CFR 1910.1200(h), at the time of initial assignment and at least annually thereafter? **(k)(3)(i)**

In addition to the information required under 29 CFR 1910.1200, does the employer: **(k)(3)(ii)**

- Provide an explanation of the contents of this section, including appendices A and B, and indicate to employees where a copy of the standard is available; **(k)(3)(ii)(A)**
- Describe the medical surveillance program required under paragraph (m) of this section, and explain the information contained in Appendix C; **(k)(3)(ii)(B)**

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YES	NO

AND

- Describe the medical removal provision required under paragraph (m) of this section? **(k)(3)(ii)(C)**

Access to Training Materials

Does the employer make readily available to all affected employees, without cost, all written materials relating to the employee training program, including a copy of this regulation? **(k)(4)(i)**

Does the employer provide to the Assistant Secretary and the Director, upon request, all information and training materials relating to the employee information and training program? **(k)(4)(ii)**

(l) Housekeeping

Are all surfaces maintained as free as practicable of visible accumulations of MDA? **(l)(1)**

Does the employer institute a program for detecting MDA leaks, spills, and discharges, including regular visual inspections of operations involving liquid or solid MDA? **(l)(2)**

Are all leaks repaired and liquid or dust spills cleaned up promptly? **(l)(3)**

Are surfaces contaminated with MDA not cleaned by the use of compressed air? **(l)(4)**

Are shoveling, dry sweeping and other methods of dry clean-up of MDA used where HEPA-filtered vacuuming and/or wet cleaning are not feasible or practical? **(l)(5)**

Are waste, scrap, debris, bags, containers, equipment, and clothing contaminated with MDA collected and disposed of in a manner to prevent the re-entry of MDA into the workplace? **(l)(6)**

(m) Medical Surveillance

General

Does the employer make a medical surveillance program available for the following employees exposed to MDA: **(m)(1)(i)**

- Employees exposed at or above the action level for 30 or more days per year; **(m)(1)(i)(A)**
- Employees who are subject to dermal exposure to MDA for 15 or more days per year; **(m)(1)(i)(B)**
- Employees who have been exposed in an emergency situation; **(m)(1)(i)(C)**
- Employees whom the employer, based on results from compliance with paragraph (e)(8) of this section, has reason to believe are being dermally exposed; **(m)(1)(i)(D)**

AND

- Employees who show signs or symptoms of MDA exposure? **(m)(1)(i)(E)**

Does the employer ensure that all medical examinations and procedures are performed by, or under the supervision of, a licensed physician, at a reasonable time and place, and provided without cost to the employee? **(m)(1)(ii)**

	YES	NO

Initial Examinations

Within 150 days of the effective date of this standard, or before the time of initial assignment, does the employer provide each employee covered by paragraph (m)(l)(i) of this section with a medical examination including the following elements: **(m)(2)(i)**

A detailed history which includes: **(m)(2)(i)(A)**

- Past work exposure to MDA or any other toxic substances; **(m)(2)(i)(A)(1)**
- A history of drugs, alcohol, tobacco, and medication routinely taken (duration and quantity); **(m)(2)(i)(A)(2)**

AND

- A history of dermatitis, chemical skin sensitization, or previous hepatic disease? **(m)(2)(i)(A)(3)**

Does the employer also provide a physical examination which includes all routine physical examination parameters, skill examination, and signs of liver disease; **(m)(2)(i)(B)**

- Laboratory tests including: **(m)(2)(i)(C)**
- Liver function tests and urinalysis; **(m)(2)(i)(C)(1),(2)**

AND

- Additional tests as necessary in the opinion of the physician? **(m)(2)(i)(D)**

Note: No initial medical examination is required if adequate records show that the employee has been examined in accordance with the requirements of this section within the previous six months prior to the effective date of this standard or prior to the date of initial assignment. **(m)(2)(ii)**

Periodic Examinations

Does the employer provide each employee covered by this section with a medical examination at least annually following the initial examination? **(m)(3)(i)**

Do these periodic examinations include at least the following elements: **(m)(3)(i)**

- A brief history regarding any new exposure to potential liver toxin, changes in drug, tobacco, and alcohol intake, and the appearance of physical signs relating to the liver, and the skin; **(m)(3)(i)(A)**
- The appropriate tests and examinations including liver function tests and skin examinations; **(m)(3)(i)(B)**

AND

- Appropriate additional tests or examinations as deemed necessary by the physician? **(m)(3)(i)(C)**

If in the physicians' opinion the results of liver function tests indicate an abnormality, is the employee removed from further MDA exposure in accordance with paragraph (m)(9) of this section? **(m)(3)(ii)**

Are repeat liver function tests conducted on advice of the physician? **(m)(3)(ii)**

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	YES	NO

Emergency Examinations

If the employer determines that the employee has been exposed to a potentially hazardous amount of MDA in an emergency situation as addressed in paragraph (d) of this section, does the employer provide medical examinations in accordance with paragraphs (m)(3)(i) and (ii) of this section? **(m)(4)**

If the results of liver function testing indicate an abnormality, is the employee removed in accordance with paragraph (m)(9) of this section? **(m)(4)**

Are repeat liver function tests conducted on the advice of the physician? **(m)(4)**

If the results of the tests are normal, are tests repeated two to three weeks from the initial testing? **(m)(4)**

Note: If the results of the second set of tests are normal and; on the advice of the physician, no additional testing is required. **(m)(4)**

Additional Examinations

Where the employee develops signs and symptoms associated with exposure to MDA, does the employer provide the employee with an additional medical examination including a liver function test? **(m)(5)**

Are repeat liver function tests conducted on the advice of the physician? **(m)(5)**

If the results of the tests are normal, are tests repeated two to three weeks from the initial testing? **(m)(5)**

Note: If the results of the second set of tests are normal and, on the advice of the physician, no additional testing is required. **(m)(5)**

Multiple Physician Review Mechanism

If the employer selects the initial physician who conducts any medical examination or consultation provided to an employee under this section, and the employee has signs or symptoms of occupational exposure to MDA (which could include an abnormal liver function test), and the employee disagrees with the opinion of the examining physician, and this opinion could affect the employee's job status, the employee may designate an appropriate, mutually acceptable second physician: **(m)(6)(i)**

- To review any findings, determinations, or recommendations of the initial physician; **(m)(6)(i)(A)**

AND

- To conduct such examinations, consultations, and laboratory tests as the second physician deems necessary to facilitate this review. **(m)(6)(i)(B)**

Does the employer promptly notify an employee of the right to seek a second medical opinion after each occasion that an initial physician conducts a medical examination or consultation pursuant to this section? **(m)(6)(ii)**

	YES	NO

Note: The employer may condition its participation in, and payment for, the multiple physician review mechanism upon the employee doing the following within fifteen (15) days after receipt of the foregoing notification, or receipt of the initial physician's written opinion, whichever is later. **(m)(6)(ii)**

The employee informing the employer that he or she intends to seek a second medical opinion, and **(m)(6)(ii)(A)**

The employee initiating steps to make an appointment with a second physician. **(m)(6)(ii)(B)**

If the findings, determinations, or recommendations of the second physician differ from those of the initial physician, then the employer and the employee shall assure that efforts are made for the two physicians to resolve any disagreement. **(m)(6)(iii)**

If the two physicians have been unable to resolve quickly their disagreement, do the employer and the employee through their respective physicians designate a third physician: **(m)(6)(iv)**

- To review any findings, determinations, or recommendations of the prior physicians; **(m)(6)(iv)(A)**

AND

- To conduct such examinations, consultations, laboratory tests, and discussions with the prior physicians as the third physician deems necessary to revolve the disagreement of the prior physicians? **(m)(6)(iv)(B)**

Does the employer act consistent with the findings, determinations, and recommendations of at least one of the third physician unless the employer and the employee reach an agreement which is otherwise consistent with the recommendations of at least one of the three physicians? **(m)(6)(v)**

Information Provided to the Examining and Consulting Physicans

Does the employer provide the following information to the examining physician: **(m)(7)(i)**

- A copy of this regulation and its appendices: **(m)(7)(i)(A)**
- A description of the affected employee's duties as they relate to the employee's potential exposure to MDA; **(m)(7)(i)(B)**
- The employee's current actual or representative MDA exposure level; **(m)(7)(i)(C)**
- A description of any personal protective equipment used or to be used; **(m)(7)(i)(D)**

AND

- Information from previous employment-related medical examinations of the affected employee? **(m)(7)(i)(E)**

Does the employer provide the foregoing information to a second physician under this section upon request whether by the second physician, or by the employee? **(m)(7)(ii)**

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	YES	NO

Physician's Written Opinion

For each examination under this section, does the employer obtain, and provide the employee with a copy of, the examining physician's written opinion within 15 days of its receipt?

Does the written opinion include the following: **(m)(8)(i)**

- The occupationally-pertinent results of the medical examination and tests; **(m)(8)(i)(A)**
- The physician's opinion concerning whether the employee has any detected medical conditions which would place the employee at increased risk of material impairment of health from exposure to MDA; **(m)(8)(i)(B)**
- The physician's recommended limitations upon the employee's exposure to MDA or upon the employee's use of protective clothing or equipment and respirators; **(m)(8)(i)(C)**

AND

- A statement that the employee has been informed by the physician of the results of the medical examination and any medical conditions resulting from MDA exposure which require further explanation or treatment? **(m)(8)(i)(D)**

Does the written opinion obtained by the employer not reveal specific findings or diagnoses unrelated to occupational exposures? **(m)(8)(ii)**

Medical Removal

Temporary Medical Removal of an Employee.

Temporary removal resulting from occupation exposure. Is the employee removed from work environments in which exposure to MDA is at or above the action level or where dermal exposure to MDA may occur, following an initial examination (paragraph (m)(2) of this section), periodic examinations (paragraph (m)(3) of this section), an emergency situation (paragraph (m)(4) of this section), or an additional examination (paragraph (m)(5) of this section) in the following circumstances: **(m)(9)(i)(A)**

- When the employee exhibits signs and/or symptoms indicative of acute exposure to MDA; **(m)(9)(i)(A)(1)**

OR

- When the examining physician determines that an employee's abnormal liver function tests are not associated with MDA exposure but that the abnormalities may be exacerbated as a result of occupational exposure to MDA? **(m)(9)(i)(A)(2)**

Temporary Removal Due to a Final Medical Determination

Does the employer remove an employee from work environments in which exposure to MDA is at or above the action level or where dermal exposure to MDA may occur, on each occasion that there is a final medical determination or opinion that the employee has a detected medical condition which places the employee at increased risk of material impairment to health from exposure to MDA? **(m)(9)(i)(B)(1)**

	YES	NO
Note: For the purposes of this section, the phase "final medical determination" shall mean the outcome of the physician review mechanism used pursuant to the medical surveillance provisions of this section. **(m)(9)(i)(B)(2)**		
Medical Removal Protection Benefits		
Provisions of Medical Removal Protection Benefits.		
Does the employer provide to an employee up to six (6) months of medical removal protection benefits on each occasion that an employee is removed from exposure from MDA or otherwise limited pursuant to this section? **(m)(9)(v)(A)**		
Note: For the purposes of this section, the requirement that an employer provide medical removal protection benefits means that the employer shall maintain the earnings, seniority, and other employment rights and benefits of an employee as though the employee had not been removed from normal exposure to MDA or otherwise limited. **(m)(9)(v)(B)**		
During the period of time that an employee is removed from normal exposure to MDA or otherwise limited, the employer may condition the provision of medical removal protection benefits upon the employee's participation in follow-up surveillance made available pursuant to this section. **(m)(9)(v)(C)**		
Workers' Compensation Claims		
If a removed employee files a claim for workers' compensation payments for a MDA-related disability, does the employer continue to provide medical removal protection benefits pending disposition of the claim?		
Note: To the extent that an award is made to the employee for earnings lost during the period of removal, the employer's medical removal protection obligation shall be reduced by such amount. The employer shall receive no credit for workers' compensation payments received by the employee for treatment-related expenses. **(m)(9)(v)(D)**		
The employer's obligation to provide medical removal protection benefits to a removed employee shall be reduced to the extent that the employee receives compensation for earnings lost during the period of removal either from a publicly or employer-funded compensation program, or receives income from non-MDA-related employment with any employer made possible by virtue of the employee's removal. **(m)(9)(v)(E)**		
Employees Who Do Not Recover Within the 6 Months of Removal		
Does the employer take the following measures with respect to any employee removed from exposure to MDA; **(m)(9)(F)**		
• Make available to the employee a medical examination pursuant to this section to obtain a final medical determination with respect to the employee; **(m)(9)(F)(1)**		
• Assure that the final medical determination obtained indicates whether or not the employee may be returned to his or her former job status, and, if not, what steps should be taken to protect the employee's health; **(m)(9)(F)(2)**		

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	YES	NO
• Where the final medical determination has not yet been obtained, or, once obtained indicates that the employer shall continue to provide medical removal protection benefits to the employee until either the employee is returned to former job status, or a final medical determination is made that the employee is incapable of ever safely returning to his or her former job status; **(m)(9)(F)(3)**		
AND		
• Where the employer acts pursuant to a final medical determination which permits the return of the employee to his or her former job status, despite what would otherwise be an abnormal liver function test, later questions concerning removing the employee again shall be decided by a final medical determination?		
Note: Employer need not automatically remove such an employee pursuant to the MDA removal criteria provided by this section. **(m)(9)(F)(4)**		
Voluntary Removal or Restriction of an Employee		
Where an employer, although not required by this section to do so, removes an employee from exposure to MDA or otherwise places limitations on an employee due to the effects of MDA exposure on the employee's medical condition, does the employer provide medical removal protection benefits to the employee equal to that required by paragraph (m)(9)(v) of this section? **(m)(9)(vi)**		
(n) Record Keeping		
Monitoring Data for Exempted Employers		
Where as a result of the initial monitoring the processing, use, or handling of products made from or containing MDA are exempted from other requirements of this section under paragraph (a)(2) of this section, does the employer establish and maintain an accurate record of monitoring relied on in support of the exemption? **(n)(1)(i)**		
Does this record include at least the following information: **(n)(1)(ii)(A)**		
• The source of the monitoring data (e.g., was monitoring performed by the employer or a private contractor); **(n)(1)(ii)(B)**		
• The testing protocol, results of testing , and/or analysis of the material for the release of MDA; **(n)(1)(ii)(C)**		
• A description of the operation exempted and how the data support the exemption (E.G., are the monitoring data representative of the conditions at the affected facility); **(n)(1)(ii)(D)**		
AND		
• Other data relevant to the operations, materials, processing or employee exposure covered by the exemption? **(n)(1)(ii)(E)**		
Does the employer maintain this record for the duration of the employer's reliance upon such objective data? **(n)(1)(ii)(F)**		

	YES	NO

Objective Data for Exempted Employers

Where the processing, use, or handling of products made from or containing MDA are exempted from other requirements of this section, does the employer establish and maintain an accurate record of objective data relied upon in support of the exemption? **(n)(2)(i)**

Does this record include at least the following information: **(n)(2)(ii)**

- The product qualifying for exemption; **(n)(2)(i)(A)**
- The source of the objective data; **(n)(2)(i)(B)**
- The testing protocol, results of testing, and/or analysis of the material for the release of MDAA; **(n)(2)(i)(C)**
- A description of the operation exempted and how the data support the exemption; **(n)(2)(i)(D)**

AND

- Other data relevant to the operations, materials, processing, or employee exposures covered by the exemption? **(n)(2)(i)(E)**

Does the employer maintain this record for the duration of the employer's reliance upon such objective data? **(n)(2)(iii)**

Exposure Measurements

Does the employer establish and maintain an accurate record of all measurements required by paragraph (e) of this section, in accordance with 29 CFR 1910.20? **(n)(3)(i)**

Does this record include; **(n)(3)(ii)**

- The dates, number, duration, and results of each of the samples taken, including a description of the procedure used to determine representative employee exposures; **(n)(3)(ii)(A)**
- Identification of the sampling and analytical methods used; **(n)(3)(ii)(B)**
- A description of the type of respiratory protective devices worn if any; **(n)(3)(ii)(C)**

AND

- The name, social security number, job classification and exposure levels of the employee monitored and all other employees whose exposure the measurement is intended to represent? **(n)(3)(ii)(D)**

Does the employer maintain this record for at least 30 years, in accordance with 29 CFR 1910.20? **(n)(3)(iii)**

Medical surveillance

Does the employer establish and maintain an accurate record for each employee subject to medical surveillance required by paragraph (m) of this section, in accordance with 29 CFR 1910.20? **(n)(4)(i)**

Does this record include: **(n)(4)(ii)**

- The name, social security number and description of the duties of the employee; **(n)(4)(ii)(A)**

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	YES	NO

- The employer's copy of the physician's written opinion on the initial, periodic, and any special examinations, including results of medical examination and all tests, opinions, and recommendations; **(n)(4)(ii)(B)**
- Results of any airborne exposure monitoring done for that employee and the representative exposure levels supplied to the physician; **(n)(4)(ii)(C)**

AND

- Any employee medical complaints related to exposure to MDA? **(n)(4)(ii)(D)**

Does the employer keep, or assure that the examining physician keeps, the following medical record: **(n)(4)(iii)**

- A copy of this standard and its appendices, except that the employer may keep one copy of the standard and its appendices for all employees provided the employer references the standard and its appendices in the medical surveillance record of each employee; **(n)(4)(iii)(A)**
- A copy of the information provided to the physician as required by any paragraphs in the regulatory text; **(n)(4)(iii)(B)**
- A description of the laboratory procedures and a copy of any standards or guidelines used to interpret the test results or references to the information; **(n)(4)(iii)(C)**
- A copy of the employee's medical and work history related to exposure to MDA? **(n)(4)(iii)(D)**
- Does the employer maintain this record for at least the duration of employment plus 30 years, in accordance with 29 CFR 1910.20? **(n)(4)(iv)**

Medical Removal

Does the employer establish and maintain an accurate record for each employee removed from current exposure to MDA pursuant to paragraph (m) of this section? **(n)(5)(i)**

Does each record include: **(n)(5)(ii)**

- The name and social security number of the employee; **(n)(5)(ii)(A)**
- The date of each occasion that the employee was removed from current exposure to MDA as well as the corresponding date on which the employee was returned to his or her former job status; **(n)(5)(ii)(B)**
- A brief explanation of how each removal was or is being accomplished; **(n)(5)(ii)(C)**

AND

- A statement with respect to each removal indicating the reason for the removal? **(n)(5)(ii)(D)**

Does the employer maintain each medical removal record for at least the duration of an employee's employment plus 30 years? **(n)(5)(iii)**

Availability

Does the employer assure that records required to be maintained by this section shall be made available, upon request, to the Assistant Secretary and the Director for examination and copying? **(n)(6)(i)**

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	YES	NO
Are employee exposure monitoring records required by this section provided upon request for examination and copying to employees, employee representatives, and the Assistant Secretary in accordance with 29 CFR 1910.20 (a)-(e) and (g)-(i)? **(n)(6)(ii)**		
Are employee medical records required by this section provided upon request for examination and copying, to the subject employee, to anyone having the specific written consent of the subject employee, and to the Assistant Secretary in accordance with 29 CFR 1910.20? **(n)(6)(iii)**		
Transfer of Records		
Does the employer comply with the requirements involving transfer of records set forth in 29 CFR 1910.20(h)? **(n)(7)(i)**		
If the employer ceases to do business and there is no successor employer to receive and retain the records for the prescribed period, does the employer notify the Director, at least 90 days prior to disposal, and transmit the records to the Director if so requested by the Director within that period? **(n)(7)(ii)**		
(o) Observation of Monitoring		
Does the employer provide affected employees, or their designated representatives, an opportunity to observe the measuring or monitoring of employee exposure to MDA conducted pursuant to paragraph (e) of this section? **(o)(i)**		
When observation of the measuring of employee exposure to MDA requires entry into areas where the use of protective clothing and equipment or respirators is required, does the employer provide the observer with personal protective clothing and equipment or respirators required to be worn by employees working in the area, assure the use of such clothing and equipment or respirators, and require the observer to comply with all other applicable safety and health procedures? **(o)(2)**		
(p)Effective date		
This standard shall become effective September 9, 1992. **(p)**		
(q) Appendices		
The information contained in appendices A, B, C, and D of this section is not intended by itself, to create any additional obligations not otherwise imposed by this standard nor detract from any existing obligation. The protocols for respiratory fit testing in Appendix E of this section are mandatory. **(q)**		

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	YES	NO
(r) Startup Dates		
Compliance with all obligations of this standard commence on the effective date except as follows: **(r)**		
Initial monitoring under paragraph (e)(2) of this section shall be completed as soon as possible but no later than December 8, 1992. **(r)(1)**		
Medical examinations under paragraph (m) of this section shall be completed as soon as possible but no later than February 8, 1993. **(r)(2)**		
Emergency plans required by paragraph (d) of this section shall be provided and available for inspection and copying as soon as possible but no later than January 7, 1993. **(r)(3)**		
Initial training and education shall be completed as soon as possible but no later than January 7, 1993. **(r)(4)**		
Hygiene and lunchroom facilities under paragraph (j) shall be in operation as soon as possible but no later than September 9, 1993. **(r)(5)**		
Respiratory Protection required by paragraph (h) of this section shall be provided as soon as possible but no later than January 7, 1993. **(r)(6)**		
Written compliance plans required by paragraph (g)(2) of this section shall be completed and available for inspection and copying as soon as possible but no later than January 7, 1993. **(r)(7)**		
OSHA shall enforce the permissible exposure limits in paragraph (c) of this section no earlier than January 7, 1993. **(r)(8)**		
Engineering controls needed to achieve the PELs must be in place September 9, 1993. **(r)(9)**		
Personal protective clothing required by paragraph (i) of this section shall be available January 7, 1993. **(r)(10)**		

(Next page is Z-101)

1910.1200 — CHEMICAL HAZARD COMMUNICATION

An Overview of the Standard*

Approximately one out of every four workers in the nation's work force is exposed to one or more chemical hazards in the course of work activity. OSHA officials estimate as many as 575,000 chemical products are used or handled within the overall industrial setting, and hundreds of new ones are introduced each year. This new standard attempts to address the many serious health problems posed by the potential exposure of workers to known or suspect chemical hazards.

Because of the seriousness of safety and health problems associated with the chemicals, it is important that information on recognizing and safeguarding against the hazards be made available to employees and employers — information that presently may be lacking. The goal of the Hazard Communication Standard is to reduce the incidence of illnesses and injuries resulting from exposure to chemicals.

Chemical exposure may cause or contribute to many serious health effects, such as heart ailments, kidney and lung damage, sterility, cancer, burns, and rashes. Some chemicals may also have the potential to cause fires and explosions, and to contribute to other serious accidents.

Purpose of Hazard Communication Standard

The purpose of federal OSHA's 1910.1200 standard is to establish uniform requirements in all states and jurisdictions to ensure that the hazards of all chemicals *produced, imported,* or *used within the United States'* manufacturing sector are evaluated, and that this hazard information is transmitted to affected employers and employees.

The standard, at present, applies to the manufacturing sectors identified by Standard Industrial Classification (SIC) Codes 20 through 39 below. OSHA has concluded that the need for hazard communication is greatest in these industries. (The agency is reserving the right to separately regulate other industrial segments in the future.)

*This overview is adapted from OSHA publication 3084, GPO 903-125(1983).

SIC# Manufacturing Industries

20. Food and kindred products
21. Tobacco manufacturers
22. Textile mill products
23. Apparel and other finished fabric products
24. Lumber, wood products
25. Furniture and fixtures
26. Paper and allied products
27. Printing, publishing, and allied industries
28. Chemicals and allied products
29. Petroleum refining and related industries
30. Rubber and miscellaneous plastic products
31. Leather and leather products
32. Stone, clay, glass, and concrete products
33. Primary metal industries
34. Fabricated metal products
35. Machinery manufacturing
36. Electrical and electronic machinery, equipment, supplies
37. Transportation equipment
38. Measuring, analyzing and controlling instruments; photographic, medical and optical goods, watches, and clocks
39. Miscellaneous manufacturing

SOURCES RESPONSIBLE FOR INFORMATION

Chemical manufacturers and importers of chemicals *must* convey hazard information to downstream employers by means of labels on containers, and by material safety data sheets (MSDS).

All covered employers are required to have a hazard communication program to provide the information to their employees. It is the responsibility of the employer to make certain that containers have required labels and other needed warnings, and that MSDS are obtained and made available to employees.

Chemical manufacturers and importers are required to provide the labels and the MSDS to ensure that all employers receive the information they need to inform and train their employees and to design and implement employee protection programs.

Hazard Evaluation

A key element of the program is the adequacy and accuracy of the hazard assessment. Chemical manufacturers and importers are required to review available scientific evidence concerning the hazards of the chemicals they produce or import. They are also required to report the information they find to their employees and to manufacturing employers who purchase their products.

Each chemical is to be evaluated for its potential to cause adverse health effects and to pose physical hazards.

Chemicals listed in one of the following sources are to be considered hazardous:

- 29 CFR Subpart Z, Toxic and Hazardous Substances, and
- Threshold Limit Values for Chemical Substances and Physical Agents in the Work Environment, American Conference of Governmental Industrial Hygienists (ACGIH).

Chemicals which have been evaluated and found to be a suspect or confirmed carcinogen in the following sources are to be reported as such:

- National Toxicological Program (NTP), Annual Report on Carcinogens,
- International Agency for Research on Cancer (IARC), Monographs, and
- 29 CFR 1910, Subpart Z.

Written Hazard Communication Program

Employers must establish a written, comprehensive hazard communication program. The program is to include provisions for container labeling, material safety data sheets, and an employee training program.

The written plan is to include:

1. A list of the hazardous chemicals in each work area,
2. The means the employer will use to inform employees of the hazards of nonroutine tasks, and
3. Hazards associated with chemicals in unlabeled pipes.

The plan is also to have procedures by which the employer will inform contractors working in their manufacturing facilities of the hazards to which their employees (contractors' employees) may be exposed.

The written program must be available to employees, their designated representatives, the Assistant Secretary for Occupational Safety and Health, and the Director of the National Institute for Occupational Safety and Health (NIOSH).

Labels and Warnings

Chemical manufacturers, importers, and distributors must be sure that containers of hazardous chemicals leaving the workplace are labeled, tagged, or marked with the identity, appropriate hazard warnings, and the name and address of the manufacturer or other responsible party.

In the workplace, each container must:

- Be labeled, tagged, or marked with the identity of hazardous chemicals contained therein, and
- Show hazard warnings appropriate for employee protection.

The hazard warning may be any type of message, words, pictures, or symbols which convey the hazards of the chemical(s) in the container.

Labels must be legible, in English (plus other languages, if desired), and prominently displayed.

Several exemptions to in-plant individual container labels are given in the standard:

- Employers can post signs or placards which convey the hazard information if there are a number of stationary containers within a work area which have similar contents and hazards.
- Various types of standard operating procedures, process sheets, batch tickets, blend tickets, and similar written materials may be substituted for container labels on stationary process equipment if they contain the same information and are readily available to employees in the work area.
- Employers are not required to label portable containers into which hazardous chemicals are transferred from labeled containers, and which are intended only for the immediate use of the employee who makes the transfer.
- Employers are not required to label pipes or piping systems.

MATERIAL SAFETY DATA SHEETS (MSDS)

Chemical manufacturers and importers must develop material safety data sheets for each hazardous chemical they produce or import.

Employers are responsible for obtaining or developing an MSDS for each hazardous chemical used in their workplaces.

Copies of the material safety data sheets for hazardous chemicals in a given work site are to be readily accessible to employees in that area. As a source of detailed information on hazards, the data sheets must be located close to workers, and readily available to them during each work shift.

What the MSDS Is to Feature

- All information in English;
- Information regarding the specific chemical identity of the hazardous chemical(s) involved and the common names;
- Information on the physical and chemical characteristics of the hazardous chemical;
- Known acute and chronic health effects and related health information;
- Exposure limits;
- Whether the chemical is considered to be a carcinogen by NTP, IARC, or OSHA;
- Precautionary measures to be taken;
- Emergency and first aid procedures;
- Identification of the person and organization responsible for preparing the MSDS

In addition, chemical manufacturers, importers, and employers should remain aware of new developments and significant information about the potential hazard. Such known information is to be added to the MSDS within three months. If the chemical is not being used, the MSDS updating can be delayed until such time as the chemical is reintroduced to the workplace.

Provisions for Hazardous Chemical Mixtures

For health hazards, the employer must list each component which is itself a health hazard and which comprises 1% or more of the mixture.

A chemical which is determined to be a carcinogen must be listed if it is present in quantities of 0.1% or greater.

The MSDS is to be provided to manufacturing purchasers at least with the first order or shipment.

The MSDS may be transmitted by mail, through a computer link-up, or by any other effective way, unless there is a specific requirement that it needs to be physically attached to the shipment.

Alternatives to MSDS

Written operating procedures, manuals, and similar documents may be used in lieu of MSDS, as long as they provide the required information and are readily accessible to employees.

The operating procedure may be used as an alternative approach for an individual chemical or a process involving one or more hazardous chemicals; however, information on each such chemical is to be included.

Employee Information and Training

Employers must establish a training and information program for all employees who may be exposed to hazardous chemicals in their work area. The training is to be given at the time of initial assignment and at any time a new hazard is introduced into the work area.

Information and discussion must include:

- Existence and requirements of the hazard communication standard;
- Components of the standard applicable to the employee's workplace;
- Operations in work area(s) where hazardous chemicals are present;
- Location where employer will keep written details about the hazards, list of hazardous chemicals and the required MSDS.

Components of a training program include:

- An explanation of how the hazard communication program is to be implemented;
- Information on how to read and interpret labels and MSDS;
- Instructions on how employees can obtain and use available information;
- Hazards of chemicals in work area;
- Protective measures employees can and are to take;

- Protective procedures employers have put into effect, such as work practices and use of personal protective devices;
- Hazard detection methods and observations workers can use to be alert to the presence of a hazardous chemical they may be exposed to, such as by visual appearance or smell.

Trade Secret Protection

The standard provides for chemical manufacturers to protect bona fide trade secret information, such as formulas, process data, or a "specific chemical identity." This standard also has provisions allowing limited disclosure to health professionals, employees, and designated representatives in emergency situations, and in situations where the knowledge is essential for medical treatment or health-related study.

Medical Emergency

In the instance of a medical emergency, a chemical manufacturer, importer, or employer must immediately disclose the specific chemical identity of a hazardous chemical to a treating physician or nurse when the information is needed for proper emergency treatment or first aid. The medical professional receiving the information is required, if requested to do so by the chemical manufacturer, importer, or employer, to provide a written statement of need and also a confidentiality agreement. The treating physician or nurse has the ultimate responsibility for determining that a medical emergency exists.

When is Disclosure Required in Nonemergency Situations?

There may be nonemergency situations when the withheld chemical identity must be disclosed to health professionals (physicians, industrial hygienists, toxicologists, epidemiologists) or to employees or designated representatives if certain conditions are met:

- The request must be in writing;
- Details of the medical or occupational health need must be described;
- The information is to be used for one or more of the following activities:
  - To assess hazards of chemicals to which employees will be exposed;
  - To conduct sampling of workplace atmosphere to determine exposure levels;
  - To conduct medical surveillance of exposed employees;
  - To provide medical treatment to exposed employees;
  - To help select appropriate personal protective devices;
  - To assess or design engineering controls or other protective measures;
  - To conduct studies on health effects of exposure.
- The request explains why the full disclosure is necessary.
- The request contains procedures to ensure the confidentiality of the trade secret.

The standard also has provisions for steps that are to be taken in the event that specific information requested by the health professional is withheld by the chemical manufacturers, importers, or employer.

YES	NO

(a) Purpose.

This section is to ensure that the hazards of all chemicals produced or imported by chemical manufacturers and importers are evaluated, and information concerning their hazards be made available and transmitted to affected employers and employees within the manufacturing sector. **(a)(1)**

Transmittal of information is to be accomplished by means of comprehensive hazard communication programs, which are to include:

Container labeling, or other Hazard warnings
Material Safety Data Sheets (MSDS)
Employee Training **(a)(1)**

This safety and health standard is intended to address the issue of evaluating and communicating chemical hazards to employers and employees in the manufacturing sector (as noted in (b) below), and to preempt any state law pertaining to this subject. **(a)(2)**

Any state which desires to assume responsibility in this area may only do so under provisions of the Occupational Safety and Health Act which deals with state jurisdiction and state plans. **(a)(2)**

(b) Scope and application.

Chemical manufacturers or importers are required to assess the hazards of chemicals they produce or import. **(b)(1)**

Employers in SIC Codes 20 through 39 (Division D, Standard Industrial Classification Manual) are required to provide information to their employees about the hazardous chemicals to which they are exposed, by means of hazard communication program, labels, and other forms of warning, MSDS, and training. **(b)(1)**

Distributors of hazardous chemicals are required by this section to transmit the required information to employers in SIC Codes 20-39. **(b)(1)**

This section applies to any chemical known to be present in the workplace in such a manner that employees may be exposed under normal conditions of use or in a foreseeable emergency. **(b)(2)**

This section applies to laboratories only as follows: **(b)(3)**

Employers shall:

(a) Ensure that labels on incoming containers of hazardous chemicals are not removed or defaced; **(b)(3)(i)**

(b) Maintain any MSDS that are received with incoming shipments of hazardous chemicals, and ensure that the MSDS are readily accessible to laboratory workers; and **(b)(3)(ii)**

(c) Ensure that laboratory employees are apprised of the hazards of the chemicals in their workplace in accordance with paragraph (h) of this section. **(b)(3)(iii)**

This section does *not* require labeling of the following chemicals: **(b)(4)**

(a) Pesticides subject to the labeling requirements of the Federal Insecticide, Fungicide, and Rodenticide Act and labeling regulations under that Act by the Environmental Protection Agency (EPA). **(b)(4)(i)**

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YES	NO

(b) Any food, food additive, color additive, drug, or cosmetic, including materials intended for use as ingredients in such products as defined in the Federal Food, Drug, and Cosmetic Act, and are subject to the labeling regulations issued under that Act by the FDA. **(b)(4)(ii)**

(c) Any distilled spirits (beverage alcohols), wine, or malt beverage intended for nonindustrial use when subject to the labeling requirements of the Federal Alcohol Administration Act issued by the Bureau of Alcohol, Tobacco, and Firearms. **(b)(4)(iii)**

(d) Any consumer product or hazardous substance as defined in the Consumer Product Safety Act and the Federal Hazardous Substances Act, when subject to a consumer product safety standard, labeling requirement, or regulations issued under those Acts by the Consumer Products Safety Commission. **(b)(4)(iv)**

This section does not apply to: **(b)(5)**

(a) Any hazardous waste as defined by the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act of 1976, when subject to regulations issued under that Act by the EPA. **(b)(5)(i)**

(b) Tobacco or tobacco products. **(b)(5)(ii)**

(c) Wood or wood products. **(b)(5)(iii)**

(d) Articles. **(b)(5)(iv)**

(e) Foods, drugs, or cosmetics intended for personal consumption by employees while in the workplace. **(b)(5)(v)**

(c) Definitions.

"Article" means a manufactured item, which: **(c)(1)**

(a) Is formed to a specific shape or design during manufacture, **(c)(1)(i)**

(b) Has end use function(s) dependent in whole or in part upon its shape or design during end use, and **(c)(1)(ii)**

(c) Does not release, or otherwise result in exposure to, a hazardous chemical under normal conditions of use. **(c)(1)(iii)**

"Assistant Secretary" — the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Dept. of Labor, or designee. **(c)(2)**

"Chemical" — any element, chemical compound, or mixture of elements and/or compounds. **(c)(3)**

"Chemical manufacturer" — an employer in SIC Codes 20 through 39 with a workplace where chemical(s) are produced for use or distribution. **(c)(4)**

"Chemical name" — the scientific designation of a chemical in accordance with the nomenclature system developed by the International Union of Pure and Applied Chemistry (IUPAC) or the Chemical Abstracts Service (CAS) rules of nomenclature, or a name which will clearly identify the chemical for the purpose of conducting a hazard evaluation. **(c)(5)**

YES	NO

"Combustible liquid" — any liquid having a flashpoint at or above 100°F (37.8°C), but below 200°F (93.3°C), except any mixture having components with flashpoints of 200°F (93.3°C), or higher, the total volume of which makes up 99% or more of the total volume of the mixture. **(c)(6)**

"Common name" — any designation or identification such as code name, code number, trade name, brand name, or generic name used to identify a chemical other than by its chemical name. **(c)(7)**

"Compressed gas":

(a) A gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psi at 70°F (21.1°C); or

(b) A gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psi at 130°F (54.4°C) regardless of the pressure at 70°F (21.1°C); or

(c) A liquid having a vapor pressure exceeding 40 psi at 100°F (37.8°C) as determined by ASTM D-323-72. **(c)(8)**

"Container" — any bag, barrel, bottle, can, cylinder, drum, reaction vessel, storage tank, or the like that contains a hazardous chemical. (For purposes of this section, pipes or piping systems are not considered to be containers.) **(c)(9)**

"Designated representative" — any individual or organization to whom an employee gives written authorization to exercise such employee's rights under this section. A recognized or certified collective bargaining agent shall be treated automatically as a designated representative without regard to written employee authorization. **(c)(10)**

"Director" — the Director, National Institute for Occupational Safety and Health, U.S. Department of Health and Human Services, or designee. **(c)(11)**

"Distributor" — a business, other than a chemical manufacturer or importer, which supplies hazardous chemicals to other distributors or to manufacturing purchasers. **(c)(12)**

"Employee" — a worker employed by an employer in a workplace in SIC Codes 20 through 39 who may be exposed to hazardous chemicals under normal operating conditions or foreseeable emergencies, including, but not limited to, production workers, line supervisors, and repair or maintenance personnel.

Office workers, grounds maintenance personnel, security personnel or nonresident management are generally not included, unless their job performance routinely involves potential exposure to hazardous chemicals. **(c)(13)**

"Employer" — a person engaged in a business within SIC Codes 20 through 39 where chemicals are either used, or are produced for use or distribution. **(c)(14)**

"Explosive" — a chemical that causes a sudden, almost instantaneous release of pressure, gas, and heat when subjected to sudden shock, pressure, or high temperature. **(c)(15)**

"Exposure" or "exposed" — means that an employee is subjected to a hazardous chemical in the course of employment through any route of entry (inhalation, ingestion, skin contact, or absorption, etc.), and include potential (e.g., accidental or possible) exposure. **(c)(16)**

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YES	NO

"Flammable" — a chemical that falls into one of the following categories:

(a) "Aerosol, flammable" — an aerosol that, when tested by the method described in 16 CFR 1500.45, yields a flame projection exceeding 18 inches at full valve opening, or a flashback (a flame extending back to the valve) at any degree of valve opening;

(b) "Gas, flammable" — means:

(i) A gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of 13% by volume or less; or

(ii) A gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air wider than 12% by volume, regardless of the lower limit;

(c) "Liquid, flammable" — means any liquid having a flashpoint below 100°F (37.8°C), except any mixture having components with flashpoints of 100°F (37.8°C) or higher, the total of which make up 99% or more of the total volume of the mixture.

(d) "Solid, flammable" — a solid, other than a blasting agent or explosive as defined in 1910.109(a), that is liable to cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious hazard.

A chemical shall be considered to be a flammable solid if, when tested by the method described in 16 CFR 1500.44, it ignites and burns with a self-sustained flame at a rate greater than one-tenth of an inch per second along its major axis. **(c)(17)**

"Flashpoint" — means the minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite when tested as follows:

(a) Tagliabue Closed Tester (See American National Standard Method of Test for Flash Point by Tag Closed Tester, Z11.24-1979 (ASTM D 56-79) for liquids with a viscosity of less than 45 Saybolt Universal Seconds (SUS) at 100°F (37.8°C), that do not contain suspended solids and do not have a tendency to form a surface film under test; or

(b) Pensky-Martens Closed Tester (see American National Standard Method of Test for Flash Point by Pensky-Martens Closed Tester, Z11.7-1979 (ASTM D 93-79) for liquids with a viscosity equal to or greater than 45 SUS a 100°F (37.8°C), or that contain suspended solids, or that have a tendency to form a surface film under test; or

(c) Setaflash Closed Tester (see American National Standard Method of Test for Flash Point by Setaflash Closed Tester (ASTM D 3278-78).

Organic peroxides, which undergo autoaccelerating thermal decomposition, are excluded from any of the flashpoint determination methods specified above. **(c)(18)**

"Foreseeable emergency" — any potential occurrence such as, but not limited to, equipment failure, rupture of containers, or failure of control equipment which could result in an uncontrolled release of a hazardous chemical into the workplace. **(c)(19)**

"Hazard warning" — any words, pictures, symbols, or combination thereof appearing on a label or other appropriate form of warning which convey the hazards of the chemical(s) in the container(s). **(c)(20)**

M5

YES	NO

"Hazardous chemical" — any chemical which is a physical hazard or a health hazard. **(c)(21)**

"Health hazard" — a chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees.

The term "health hazard" includes chemicals which are carcinogens, toxic, or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic system, and agents which damage the lungs, skin, eyes, or mucous membranes.

Appendix A provides further definitions and explanations of the scope of health hazards covered by this section, and

Appendix B describes the criteria to be used to determine whether or not a chemical is to be considered hazardous for purposes of this standard. **(c)(22)**

"Identity" — any chemical or common name which is indicated on the material safety data sheet (MSDS) for the chemical.

The identity used shall permit cross-references to be made among the required list of hazardous chemicals, the label and the MSDS. **(c)(23)**

"Immediate use" — means that the hazardous chemical will be under the control of and used only by the person who transfers it from a labeled container and only within the work shift in which it is transferred. **(c)(24)**

"Importer" — the first business with employees within the Customs Territory of the United States which receives hazardous chemicals produced in other countries for the purpose of supplying them to distributors or manufacturing purchasers within the United States. **(c)(25)**

"Label" — any written, printed, or graphic material displayed on or affixed to containers of hazardous chemicals. **(c)(26)**

"Manufacturing purchaser" — an employer with a workplace classified in SIC Codes 20 through 39 who purchases a hazardous chemical for use within that workplace. **(c)(27)**

"Material safety data sheet (MSDS)" — written or printed material concerning a hazardous chemical which is prepared in accordance with paragraph (g) of this section. **(c)(28)**

"Mixture" — any combination of two or more chemicals if the combination is not, in whole or in part, the result of a chemical reaction. **(c)(29)**

"Organic peroxide" — an organic compound that contains the bivalent-O-O-structure, and which may be considered to be a structural derivative of hydrogen peroxide where one or both of the hydrogen atoms has been replaced by an organic radical. **(c)(30)**

"Oxidizer" — a chemical other than a blasting agent or explosive as defined in 1910.109(a), that initiates or promotes combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases. **(c)(31)**

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YES	NO

"Physical hazard" — a chemical for which there is scientifically valid evidence that it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer, pyrophoric, unstable (reactive), or water-reactive. **(c)(32)**

"Produce" — to manufacture, process, formulate, or repackage. **(c)(33)**

"Pyrophoric" — a chemical that will ignite spontaneously in air at a temperature of 130°F (54.4°C) or below. **(c)(34)**

"Responsible party" — someone who can provide additional information on the hazardous chemical and appropriate emergency procedures, if necessary. **(c)(35)**

"Specific chemical identity" — the chemical name, Chemical Abstracts Service (CAS) Registry Number, or any other information that reveals the precise chemical designation of the substance. **(c)(36)**

"Trade secret" — any confidential formula, pattern, process, device, information, or compilation of information that is used in an employer's business, and that gives the employer an opportunity to obtain an advantage over competitors who do not know or use it. Appendix D (page Z-118) sets out the criteria to be used in evaluating trade secrets. **(c)(37)**

"Unstable (reactive)" — a chemical which in the pure state, or as produced or transported, will vigorously polymerize, decompose, condense, or will become self-reactive under conditions of shocks, pressure, or temperature. **(c)(38)**

"Use" — to package, handle, react, or transfer. **(c)(39)**

"Water-reactive" — a chemical that reacts with water to release a gas that is either flammable or presents a health hazard. **(c)(40)**

"Work area" — a room or defined space in a workplace where hazardous chemicals are produced or used, and where employees are present. **(c)(41)**

"Workplace" — an establishment at one geographical location containing one or more work areas. **(c)(42)**

(d) Hazard Determination.

An evaluation of chemical hazards shall be made of chemicals produced in the workplace(s) of chemical manufacturer. **(d)(1)**

Importers shall evaluate chemicals imported by them to determine if they are hazardous. **(d)(1)**

Employers at firms which are users of chemicals are not required to conduct evaluation of chemicals unless they choose not to rely on the chemical manufacturer's or importers' evaluations. **(d)(1)**

Has an evaluation of the chemical(s) been made to satisfy this requirement by at least one of the above? **(d)(1)**

Available scientific evidence shall be identified and considered in evaluating chemicals and hazards associated with them. **(d)(2)**

Evidence which is statistically significant, and which is based on at least one positive study conducted in accordance with established scientific principles, is considered sufficient to establish a hazardous effect if the results of the study meet the definitions of health hazards in this section. **(d)(2)**

	YES	NO
See Appendix A for scope of health hazards covered. (d)(2)		
See Appendix B for criteria to be followed regarding completeness of evaluation(s), and date to be reported. (d)(2)		
In evaluating chemicals, the following sources are to be treated as establishing that the chemicals listed in them are hazardous: (d)(3)		
29 CFR Part 1910, Subpart Z, or (d)(3)(i)		
Threshold Limit Values (TLV) for Chemical Substances and Physical Agents in the Work Environment, American Conference of Governmental Industrial Hygienist (ACGIH) (latest edition). (d)(3)(ii)		
NOTE: Responsibility for evaluating the hazards associated with chemicals in these source lists in accordance with this standard remains with the chemical manufacturer, importer, and employer. (d)(3)		
Chemicals are to be treated as carcinogens or as potential carcinogens for hazard communication purposes if they are included in the following source lists: (d)(4)		
National Toxicology Program (NTP) *Annual Report on Carcinogens* (latest edition); (d)(4)(i)		
International Agency for Research on Cancer, (IARC) *Monographs* (latest edition); (d)(4)(ii)		
or 29 CFR Part 1910. Subpart Z. (d)(4)(iii)		
NOTE: The *Registry of Toxic Effects of Chemical Substances* published by NIOSH indicates whether a chemical has been found to be a potential carcinogen by NTP or IARC. (d)(4)		
Hazards of chemical mixtures shall be determined as follows: (d)(5)		
(a) If a mixture is tested as a whole, the test result shall be used to determine if the mixture is hazardous. (d)(5)(i)		
(b) If a mixture has not been tested as a whole, the mixture shall be assumed to present the same health hazards as do components which comprise one percent or more (by weight or volume) of the mixture; except that the mixture shall be assumed to present a carcinogenic hazard if it contains a component in concentrations of 0.1 percent or greater which is considered to be a carcinogen under paragraph (d)(4) of this section. (d)(5)(ii)		
(c) If a mixture has not been tested as a whole, whatever scientifically valid data is available may be used to evaluate the physical hazard potential of the mixture. (d)(5)(ii)		
A written description of the procedures used to determine the hazards of chemicals that are evaluated is required to be prepared by chemical manufacturers, importers or employers. (d)(6)		
a) The written procedures are to be made available, upon request, to employees, their designated representatives, the Assistant Secretary and the Director. (d)(6)		
b) The written description may be incorporated into the hazard communication program required under paragraph (e) of this section. (d)(6)		

	YES	NO
(e) Written hazard communication program.		
Employers shall develop and implement a hazard communication program in writing for their workplace(s). (e)(1)		
The written program is to describe how the criteria specified in paragraphs (f), (g) and (h) of this section will be met, for:		
Labels and other forms of warnings, Material safety data sheets, Employee information and training, and which also includes a list of hazardous chemicals known to be present in the workplace using an identity referenced on the appropriate MSDS. (e)(1)(i)		
NOTE: The list may be compiled for the workplace as a whole or for individual work areas.		
The written program will describe methods that will be used to inform employees of the hazards of nonroutine tasks (for example, cleaning of reactor vessels), and hazards associated with chemicals in unlabeled pipes in their work areas. (e)(1)(ii)		
Methods that will be used to inform any contractors who have their employees working in the workplace of the hazardous chemicals their employees may be exposed to while performing their work are to go into the program. (e)(1)(iii)		
Suggestions are to be included for appropriate protective measures for contractor's employees. (e)(1)(iii)		
An existing hazard communication program that meets the criteria established in this paragraph (e), may be relied upon by the employer to comply with these requirements. (e)(2)		
The written communication program shall be made available, upon request, to employees, their designated representatives, the Assistant Secretary, and the Director, in accordance with requirements of 29 CFR 1910.20(e). (e)(3)		
(f) Labels and other forms of warning.		
The chemical manufacturer, importer, or distributor shall sure that each container of hazardous chemicals leaving the workplace is labeled, tagged, or marked with the following information: (f)(1)		
a) Identity of the hazardous chemical(s), (f)(1)(i)		
b) Appropriate hazard warning, and (f)(1)(ii)		
c) Name and address of the chemical manufacturer. (f)(1)(iii)		
Containers of hazardous chemicals leaving the workplace shall be labeled, tagged, or marked in accordance with this section and in a manner that does not conflict with requirements of the Hazardous Materials Transportation Act (18 V.S.C. 1801 et seq.) and regulations issued under that act by the Department of Transportation. (f)(2)		
If the hazardous chemical is regulated by OSHA in a substance-specific health standard, the labels or other forms of warning used shall be in accordance with the requirement of that standard. (f)(3)		

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	YES	NO
Except as provided in paragraphs (f)(5) and (f)(6), each container of hazardous chemicals in the workplace shall be labeled, tagged, or marked with the following information: (f)(4)		
a) Identity of hazard (f)(1)(i)		
b) Appropriate hazard warnings (f)(1)(ii)		
Signs, placards, process sheets, batch tickets, operating procedures, or other such written materials may be used in lieu of affixing labels to individual stationary process containers, as long as the information required by paragraph (f)(4) of this section to be on a label is conveyed by the alternative method, and (f)(5)		
The written material shall be readily accessible to employees in their work area throughout each work shift. (f)(5)		
Portable containers into which hazardous chemicals are transferred from labeled containers, and which are intended only for the immediate use of the employee who performs the transfer, are not required to be labeled. (f)(6)		
Existing labels on incoming containers of hazardous materials shall not be removed or defaced, unless the container is immediately marked with the required information. (f)(7)		
The employer shall ensure that labels or other forms of warning are legible, in English, and prominently displayed on the container, or readily available in the work area throughout each work shift. (f)(8)		
If necessary to satisfy the need of employees who speak other languages, the information in the other language or languages may be added to the material presented, as long as the information is presented in English as well. (f)(8)		
Containers that are received with labels affixed that convey the information required by this section, do not require new labeling. (f)(9)		
(g) Material safety data sheets.		
Chemical manufacturers and importers are responsible for a material safety data sheet to be obtained or developed for each hazardous chemical produced or imported. (g)(1)		
Employers are required to have a material safety data sheet for each hazardous chemical used in his or her workplace. (g)(1)		
Material safety data sheets shall be in English and contain at least the following information: (g)(2)		
The identity used on the label, and except a provided for in paragraph (f) of this section on trade secrets: (g)(2)(i)		
(A) Its chemical and common name(s) if the hazardous chemical is a single substance;		
(B) The chemical and common name(s) of the ingredients which contribute to the known hazards if the chemical is a mixture which has been tested as a whole, and also the common name of the mixture itself; or,		
(C) If the mixture has not been tested as a whole:		
(1) The chemical and common name(s) of ingredients which comprise one percent or greater of the composition and which have been determined to be health hazards;		

	YES	NO
(2) The chemical and common name(s) of ingredients identified as carcinogens under paragraph (d) (4), if the concentrations are 0.1% or greater; and		
(3) The chemical and common name(s) of all ingredients which present a physical hazard when present in the mixture: (g)(2)(i)		
Physical and chemical characteristics (such as vapor pressure, and flash point). (g)(2)(ii)		
Physical and chemical characteristics, including potential for fire, explosion, and reactivity. (g)(2)(iii)		
Potential health hazards, including indications or symptoms of exposure to be aware of, and any medical conditions which are generally recognized as being aggravated by exposure to the chemical. (g)(2)(iv)		
Primary route(s) of entry. (g)(2)(v)		
Permissible exposure limit(s) used, established, or recommended by: (g)(2)(vi)		
OSHA, ACGIH Threshold Limit Value, and The limits used or recommended by the chemical manufacturer, importer, or employer preparing the material safety data sheet, where available. (g)(2)(vi)		
Whether the chemical is listed or has been found to be a potential carcinogen by: (g)(2)(vii)		
OSHA, NTP Annual Report on Carcinogens (latest editions), or IARC Monographs (latest editions). (g)(2)(vii)		
Generally applicable precautions for safe handling and use known to the preparer of the material safety data sheet, including: (g)(2)(viii)		
Appropriate hygiene practices Protective measures during repair and maintenance of contaminated equipment Procedures for clean-up of spills and leaks (g)(2)(viii)		
Generally applicable control measures, including: (g)(2)(ix)		
engineering controls work practices personal protective equipment		
Emergency and first aid procedures (g)(2)(x)		
Date of MSDS preparation or date of last change (g)(2)(xi)		
Name, address, and telephone number of the responsible party preparing or distributing the MSDS who can provide additional information on the hazardous chemical and appropriate emergency procedures, if necessary. (g)(2)(xii)		
All spaces on the MSDS must be completed. Any given category for which no relevant information was found is to be marked to indicate that no applicable information was found. (g)(3)		
Where complex mixtures have similar hazards and contents, it may be permissible to prepare one MSDS to apply to all similar mixtures. (g)(4)		
The responsible party preparing the MSDS shall ensure that the information recorded accurately reflects the scientific evidence used in making the hazard determination. (g)(5)		

YES	NO

If the responsible party becomes aware of any significant new information regarding the hazards of a chemical, or ways to protect against the hazards, this new information shall be added to the MSDS within three months; or, **(g)(5)**

If the chemical is not currently being produced or imported, the information is to be added to the MSDS before the chemical is introduced into the workplace again. **(g)(5)**

Chemical manufacturers or importers shall ensure that appropriate MSDS are provided with initial shipments to distributors and manufacturing purchasers of hazardous chemicals, and with the first shipment after an MSDS is updated. **(g)(6)**

The MSDS shall be provided either by:

(a) Including them with the shipped containers, or
(b) Sending them to the manufacturing purchaser prior to or at the time of shipment. **(g)(6)**

If the MSDS is not provided with the shipment, the manufacturing purchaser shall obtain one as soon as possible from the chemical manufacturer, importer, or distributor. **(g)(6)**

It is the responsibility of distributors to ensure that required MSDSs and updated information are provided to other distributors and manufacturing purchasers. **(g)(7)**

Copies of required MSDSs are to be maintained by the employer for:

(a) Each hazardous chemical in the workplace, and
(b) Ensuring that they are readily accessible during each workshift to employees when they are in their work area(s). **(g)(8)**

MSDS may be kept in any effective form that will ensure the required information is provided for each hazardous chemical, and is readily accessible during each workshift to employees in their work area(s), including:

(a) Operating procedures, and
(b) A means designed to cover groups of hazardous chemicals in a work area, in instances where it is more appropriate to address the hazards of a process rather than individual hazardous chemicals. **(g)(9)**

MSDS shall be made available, upon request, to designated employee representatives, the Assistant Secretary, and the Director in accordance with requirements of 29 CFR 1910.20(e). **(g)(10)**

(h) Employee information and training.

Employers shall provide employees with information and training on hazardous chemicals in their work area at time of their initial assignment and whenever a new hazard is introduced into their work area.

Information. **(h)(1)**

Employees shall be informed of:

The requirements of this section; **(h)(1)(i)**

Operations in their area where hazardous chemicals are present; **(h)(1)(ii)**

YES	NO

Location and availability of written hazard communication program, including:

Required list(s) of hazardous chemicals; required MSDSs. **(h)(1)(iii)**

Training. **(h)(2)**

Employee training shall include at least:

(a) Methods and observations that may be used to detect presence of release of a hazardous chemical in the work area (such as: monitoring conducted by the employer, continuous monitoring devices, visual appearance or odor of hazardous chemical when being released, etc.); **(h)(2)(i)**

(b) Physical and health hazards of the chemicals in the work area; **(h)(2)(ii)**

(c) Protective measures an employee can take; **(h)(2)(iii)**

(d) Specific procedures the employer has implemented to protect employees from exposure to hazardous chemicals, such as appropriate work practices, emergency procedures, and personal protective devices to be used; and **(h)(2)(iii)**

(e) Details of the employer's hazard communication program, including:

An explanation of the labeling system,
An explanation of the MSDSs, and
How employees can obtain and use the appropriate hazard information. **(h)(2)(iv)**

(i) Trade secrets

The chemical manufacturer, importer or employer may withhold the specific chemical identity from the MSDS, provided that: **(i)(1)**

The claim that the information withheld is a trade secret can be supported; **(i)(1)(i)**

Information contained in the MSDS concerning the properties and effects of the hazardous chemical is disclosed; **(i)(1)(ii)**

The MSDS indicates that the specific chemical identity is being withheld as a trade secret; **(i)(1)(iii)**

The specific chemical identity is made available to health professionals, employees, and their designated representatives in accordance with applicable provisions of this paragraph. **(i)(1)(iv)**

Where it is determined that a medical emergency exists by a treating physician or nurse, and the specific chemical identity of a hazardous chemical is necessary for emergency or first-aid treatment, the chemical manufacturer, importer, or employer shall immediately disclose the specific chemical identity of a trade secret chemical to that treating physician or nurse, *regardless* of the existence of a written statement of need or a confidentiality agreement. **(i)(2)**

A written statement of need and a confidentiality agreement, in accordance with the provisions of paragraphs (i)(3) and (4) of this section, may be required from the requesting physician or nurse. **(i)(2)**

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	YES	NO
In non-emergency situations, disclosure of specific chemical identity, otherwise permitted to be withheld, may be required, upon request, to be made to a health professional (i.e., physician, industrial hygienist, toxicologist, epidemiologist), providing medical or occupational health services to exposed employees, and to employees or designated representatives, if: **(i)(3)**		
The request is in writing; **(i)(3)(i)**		
The request describes one or more of the following needs for the information: **(i)(3)(ii)**		
(A) To assess the hazards of the chemicals to which employees will be exposed;		
(B) To conduct or assess sampling of workplace atmosphere to determine employee exposure levels;		
(C) To conduct pre-assignment or periodic medical surveillance of exposed employees;		
(D) To provide medical treatment to exposed employees;		
(E) To select or assess appropriate personal protective equipment;		
(F) To design or assess engineering controls or other protective measures:		
(G) To conduct studies to determine health effects of exposure. **(i)(3)(ii)**		
The request explains why disclosure of the specific chemical identity is essential, and that, in lieu thereof, the disclosure of the following information to the health professional, employee, or designated representative, would not satisfy the purposes described in paragraph (i)(3)(ii) of this section:		
(A) The properties and effects of the chemical;		
(B) Measures for controlling workers' exposure to the chemical;		
(C) Methods of monitoring and analyzing worker exposure to the chemical; and,		
(D) Methods of diagnosing and treating harmful exposures to the chemical. **(i)(3)(iii)**		
The request includes a description of procedures to be used to maintain confidentiality of the disclosed information; and **(i)(3)(iv)**		
The health professional, and the employer or contractor of the health professional, employee, or designated representative, agree in a *written confidentiality agreement,* not to use the trade secret information for any purpose other than the health need(s) asserted; and **(i)(3)(v)**		
Agree not to release the information under any circumstances other than to OSHA, except as authorized by terms of the agreement or by the chemical manufacturer, importer, or employer. **(i)(3)(v)**		
The confidentiality agreement authorized by paragraph (i)(3)(iv) of this section, may:		
(a) Restrict use of the information to the purposes indicated in the statement of need. **(i)(4)(i)**		
(b) Provide for legal remedies and stipulation of a pre-estimate of likely dangers in event of a breach of the agreement. **(i)(4)(ii)**		

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	YES	NO
(c) Not include requirements for posting of a penalty bond. **(i)(4)(iii)**		
Nothing in this standard is meant to preclude the parties from pursuing non-contractual remedies to the extent permitted by law. **(i)(5)**		
The chemical manufacturer, importer, or employer who provided the trade secret information shall be informed by the health professional, employee, or designated representative of any disclosure of the information to OSHA prior to or at the same time as the disclosure. **(i)(6)**		
If a written request for disclosure of a specific chemical identity is denied, the denial must: **(i)(7)**		
(a) Be provided within 30 days of the request. **(i)(7)(i)**		
(b) Be in writing. **(i)(7)(ii)**		
(c) Be supported by evidence that the specific chemical identity is a trade secret. **(i)(7)(iii)**		
(d) Specifically state reasons for denial. **(i)(7)(iv)**		
(e) Explain how alternative information may satisfy the specific medical or occupational health need without revealing the specific chemical identity. **(i)(7)(v)**		
Health professionals, employees, or designated representatives whose request for information is denied may refer the request and the written denial to OSHA for consideration. **(i)(8)**		
When a denial is referred to OSHA, the agency shall consider the evidence to determine if: **(i)(9)**		
(a) There is evidence to support the claim that the specific chemical is a trade secret. **(i)(9)(i)**		
(b) There is support for the health professional, employee, or designated representative's claim of a medical or occupational need for the information. **(i)(9)(ii)**		
(c) Adequate means to protect the confidentiality is demonstrated. **(i)(9)(iii)**		
The chemical manufacturer, importer, or employer denying a request may be subject to citation by OSHA, if: **(i)(10)**		
(a) OSHA determines that the specific chemical identity requested is not a *bona fide* trade secret, or		
(b) OSHA determines it is a trade secret, but the requestor has a legitimate medical or occupational health need, has executed a written confidentiality agreement, and has shown adequate means to protect the confidentiality of the information **(i)(10)(i)**		
If it is demonstrated to OSHA that a confidentiality agreement would not provide sufficient protection against the potential harm from the unauthorized disclosure of a trade secret specific chemical identity, OSHA may impose additional limitations or conditions upon the disclosure of the requested chemical information to assure that the occupational health services are provided without an undue risk of harm to the chemical manufacturer, importer, or employer. **(i)(10)(ii)**		
If the information continues to be withheld following issuance of a citation and protective orders, the matter is referrable to the Occupational Safety and Health Review Commission for enforcement of the citation. **(i)(11)**		

YES	NO

In accordance with Commission rules, the Administrative Law Judge may review the citation and supporting documents *in camera* or issue appropriate protective orders. **(i)(11)**

Notwithstanding existence of a trade secret claim, a chemical manufacturer, importer, or employer shall, upon request, disclose to the Assistant Secretary any information which this section requires to be made available. **(i)(12)**

Where there is a trade secret claim, such claim shall be made no later than at the time the information is provided to the Assistant Secretary so that suitable determination of trade secret status can be made and necessary protection can be implemented. **(i)(12)**

Nothing in this paragraph shall be construed, under any circumstances, requiring disclosure of process or percentage of mixture information which is trade secret. **(i)(13)**

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YES	NO

(j) Effective dates.

By November 25, 1985:

Chemical manufacturers and importers shall label containers of hazardous chemicals leaving their workplaces and provide material safety data sheets with initial shipments **(j)(1)**

November 25, 1985:

Distributors shall be in compliance with all provisions applicable to them. **(j)(2)**

May 25, 1986:

Employers shall be in compliance with all provisions of this section, including initial training for all current employees.

03

1910.1450 — OCCUPATIONAL EXPOSURE TO HAZARDOUS CHEMICALS IN LABORATORIES

YES | NO

(a) Scope and application

This section applies to all employers engaged in the laboratory use of hazardous chemicals. **(a)(1)**

Where this section applies, it replaces the requirements of all other OSHA health standards in 29 CFR part 1910, Subpart Z, except as follows:

For any OSHA health standard, only the requirement to limit employee exposure to the specific permissible exposure limit shall apply for laboratories, unless that particular standard states otherwise or unless the conditions of paragraph (a)(2)(iii) of this section apply **(a)(2)(i)**

Prohibition of eye and skin contact where specified by any OSHA health standard will be observed. **(a)(2)(ii)**

Where the action level (or, in the absence of an action level, the PEL) is routinely exceeded for an OSHA-regulated substance with exposure monitoring and medical surveillance requirements, paragraphs (d) and (g)(1)(ii) of this section apply. **(a)(2)(iii)**

This section shall not apply to:

Uses of hazardous chemicals which do not meet the definition of laboratory use, and in such cases, the employer shall comply with the relevant standard in 29 CFR part 1910, Subpart Z, even if such use occurs in a laboratory.

Laboratory uses of hazardous chemicals which provide no potential for employee exposure. Examples of such conditions might include:

Procedures using chemically-impregnated test media such as Dip-and-Read tests where a reagent strip is dipped into the specimen to be tested and the results are interpreted by comparing the color reaction to a color chart supplied by the manufacturer of the test strip; and

Commercially-prepared kits such as those used in performing pregnancy tests in which all of the reagents needed to conduct the test are contained in the kit.

(b) Definitions

See page Z-iv.

Permissible exposure limits

For laboratory uses of OSHA-regulated substances, has the employer assured that employee exposure does not exceed the permissible exposure limits specified in 29 CFR part 1910, Subpart Z? **(c)**

Employee exposure

If there is reason to believe that exposure levels for a particular substance exceed the action level or PEL, is employee exposure monitored? **(d)(1)**

If the initial monitoring shows employee exposure to be over the action level or PEL, are the exposure monitoring provisions immediately complied with? **(d)(2)**

Is monitoring terminated only in accordance with the relevant standard? **(d)(3)**

Are employees notified of monitoring results within 15 working days after the receipt of those results? (Employers can notify employees individually or by posting the results in an appropriate location that is accessible to employees.) **(d)(4)**

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YES | NO

Chemical hygiene plan

(**Note**: Appendix A of this section is not mandatory, but provides guidance to assist employers in developing a Chemical Hygiene Plan. See page Z-App-155.)

Where hazardous chemicals as defined by this standard are used in the workplace, are provisions of a written Chemical Hygiene Plan (CHP) carried out? **(e)(1)**

Does the CHP protect employees from health hazards associated with hazardous chemicals in laboratories, and does it keep exposures below the limits specified in paragraph (c) of this section?

Is the CHP readily available to employees, employee representatives, and to the Assistant Secretary, upon request? **(e)(2)**

Does the CHP include each of the following elements and indicate specific measures that the employer will take to ensure laboratory employee protection:

Standard operating procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals;

Criteria that the employer will use for determining employee exposure to hazardous chemicals and for implementing control measures to reduce this exposure, including engineering controls, the use of personal protective equipment, and hygiene practices;

A requirement that fume hoods and other protective equipment are functioning properly and specific measures that shall be taken to ensure proper and adequate performance of such equipment;

Provisions for employee information and training as prescribed in paragraph (f) of this section;

The circumstances under which a particular laboratory operation, procedure, or activity requires prior approval from the employer or the employer's designee before implementation;

Provisions for medical consultation and medical examinations in accordance with paragraph (g) of this section; and

Designation of personnel responsible for implementing the Chemical Hygiene Plan, including the assignment of a Chemical Hygiene Officer and, if appropriate, establishment of a Chemical Hygiene Committee. **(e)(3)(i)-(vii)**

Are provisions made for additional employee protection for work with particularly hazardous substances? **(e)(viii)**

(**Note**: These include "select carcinogens," reproductive toxins, and substances which have a high degree of acute toxicity.)

Is specific consideration given to the following provisions which shall be included where appropriate:

The establishment of a designated area;

Use of containment devices such as fume hoods or glove boxes;

Procedures for safe removal of contaminated waste; and

Decontamination procedures.

Is the effectiveness of the CHP reviewed and evaluated at least annually and updated as necessary? **(e)(4)**

1910.1450 — OCCUPATIONAL EXPOSURE TO HAZARDOUS CHEMICALS IN LABORATORIES

	YES	NO
Employee information and training		
Are employees provided with information and training to ensure that they are aware of the hazards of chemicals present in their work area? **(f)(1)**		
Is this information provided at the time of the employee's initial assignment to a work area where hazardous chemicals are present and prior to assignments involving new exposure situations? **(f)(2)**		
Are affected employees informed of the following:		
The contents of this standard and its appendices which shall be made available to employees;		
The location and availability of the employer's Chemical Hygiene Plan;		
The permissible exposure limits for OSHA-regulated substances or recommended exposure limits for other hazardous chemicals where there is no applicable OSHA standard;		
Signs and symptoms associated with exposure to hazardous chemicals used in the laboratory; and		
The location and availability of known reference material on the hazards, safe handling, storage, and disposal of hazardous chemicals found in the laboratory including, but not limited to, Material Safety Data Sheets (MSDSs) received from the chemical supplier. **(f)(3)**		
Training		
Does employee training include the following:		
Methods and observations that may be used to detect the presence or release of a hazardous chemical (such as monitoring conducted by the employer, continuous monitoring devices, visual appearance or odor of hazardous chemicals when being released, etc.);		
The physical and health hazards of chemicals in the work area; and		
The measures employees can take to protect themselves from these hazards, including specific procedures the employer has implemented to protect employees from exposure to hazardous chemicals, such as appropriate work practices, emergency procedures, and personal protective equipment. **(f)(4)**		
Are employees trained on the applicable details of the CHP?		
Medical consultations		
Under the following circumstances, are all employees who work with chemicals provided with an opportunity to receive medical attention:		
Whenever an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory, is that employee provided an opportunity to receive an appropriate medical examination? **(g)(1)(i)**		
Where exposure monitoring reveals an exposure level routinely above the action level (or in the absence of an action level, the PEL) for an OSHA-regulated substance for which there are exposure monitoring and medical surveillance requirements, is medical surveillance established for the affected employee? **(g)(1)(ii)**		

1910.1450 — OCCUPATIONAL EXPOSURE TO HAZARDOUS CHEMICALS IN LABORATORIES

	YES	NO
Whenever an event takes place in the work area such as a spill, leak, explosion, or other occurrence resulting in the likelihood of a hazardous exposure, are affected employees provided an opportunity for a medical consultation?		
Are all medical examinations and consultations performed by or under the direct supervision of a licensed physician, and are they provided without cost to the employee, without loss of pay, and at a reasonable time and place? **(g)(2)**		
Is the following information provided to the physician:		
The identity of the hazardous chemical(s) to which the employee may have been exposed;		
A description of the conditions under which the exposure occurred including quantitative exposure data, if available; and		
A description of the signs and symptoms of exposure that the employee is experiencing, if any. **(g)(3)(i)-(iii)**		
For examination or consultation required under this standard, does the employer obtain a written opinion from the examining physician which includes the following:		
Any recommendation for further medical follow-up;		
The results of the medical examination and any associated tests;		
Any medical condition which may be revealed in the course of the examination which may place the employee at increased risk as a result of exposure to a hazardous chemical found in the workplace; and		
A statement that the employee has been informed by the physician of the results of the consultation or medical examination and any medical condition that may require further examination or treatment. **(g)(4)**		
The written opinion should not reveal specific findings of diagnoses unrelated to occupational exposure.		
Hazard identification		
With respect to labels and MSDSs:		
Has it been ensured that labels on incoming containers of hazardous chemicals are not removed or defaced?		
Are all MSDSs that are received with incoming shipments of hazardous chemicals maintained and readily accessible to laboratory employees? **(h)(1)**		
If the composition of a chemical substance produced exclusively for the laboratory is known, has the employer determined if it is a hazardous chemical as defined in paragraph (b) of this section?		
If the chemical is determined to be hazardous, is the appropriate training as required under paragraph (f) of this section provided?		
If the chemical produced is a byproduct and the composition is not known, is it assumed that the substance is hazardous and are the provisions of paragraph (e) of this section complied with? **(h)(2)**		
If the chemical substance is produced for another user outside of the laboratory, are the requirements of the Hazard Communication Standard (29 CFR 1910.1200) complied with, including the requirements for preparation of MSDSs and labeling? **(h)(2)(iii)**		

S7

1910.1450 — OCCUPATIONAL EXPOSURE TO HAZARDOUS CHEMICALS IN LABORATORIES

	YES	NO
Use of respirators		
Where respirators are needed to keep exposure below the PEL, is respiratory equipment provided at no cost to the employees? **(i)**		
Are respirators selected and used in accordance with the requirements of 29 CFR 1910.134, under Orange Tab I?		
Recordkeeping		
Are accurate records for each employee maintained for any measurements taken to monitor that employee's exposure and any medical consultation and examinations, including tests or written opinions required by this standard? **(j)(1)**		
Are these records kept, transferred, and made available in accordance with 29 CFR 1910.20, under Orange Tab C? **(j)(2)**		
Dates		
This section becomes effective 5/1/90. Employers must develop and implement a written Chemical Hygiene Plan no later than January 31, 1991. Paragraph (a)(2) of this section shall not take effect until the employer has developed and implemented a written Chemical Hygiene Plan. (Appendices A and B to this section are located on page Z-App-155)		

YES	NO

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APPENDIX — SUBPART Z

Exposure limits for chemicals found in the workplace are listed in OSHA tables Z-1-A , Z-2, and Z-3. Explanations for these tables and the tables themselves appear below. Hazardous substances in the workplace that are not found in these tables are covered by the hazard communication standard 1910.1200 (page Z-101 in the self-inspection checklist, Subpart Z).

Administrative or engineering controls must first be implemented whenever feasible to keep exposures below the limits set in tables Z-1-A, Z-2, and Z-3. When such controls are not feasible to achieve full compliance, protective equipment or other protective measures must be used to keep employee exposures within prescribed limits. Any equipment must be approved by a competent industrial hygienist or other qualified person. Whenever respirators are used, they must comply with the requirements of Subpart I, 1910.134.

Table Z-1-A

Table Z-1-A lists exposure limits for certain workplace chemicals, including transitional limits, ceiling values and time weighted averages. Limits are expressed as ppm (parts per million parts of air by volume at 25°C and 760mm Hg pressure) and as mg/M_3, (milligrams of particulate per cubic meter of air).

Traditional limits columns and ceiling values. Exposure to substances in transitional limits columns, preceded by a C (example, C Boron trifluoride) in table Z-1-A shall not exceed the ceiling value (exposure limit) given for that substance.

Time weighted averages. A woker's exposure to any substance in Table Z-1-A under the transitional limits column, which is not preceded by a C must not exceed the 8-hour time weighted average for given material in the table.

Table Z-2

Employee exposure to any material listed in table Z-2 in any 8-hour work shift of a 40-hour week must not exceed the time weighted average limit given in the table. Substances in table Z-2 are also measured in terms of parts per million parts of air (ppm) and milligrams (or micrograms) per cubic meter of air (mg/M^3 or $\mu g/M^3$).

Employee exposure to any material in table Z-2 must not exceed at any time during an 8-hour shift the ceiling concentration limit given in the table, except as allowed in the column "acceptable maximum peak above the acceptable ceiling concentration for an 8-hour shift."

Example: During an 8-hour work shift, an employee may be exposed to a concentration of benzene above 25 ppm (but never above 50 ppm) only for a maximum period of 10 minutes. Such exposure must be compensated by exposures to concentrations less than 10 ppm so that the cumulative exposure for the entire 8-hour work shift does not exceed a TWA of 10 ppm.

Table Z-3

Employee exposure during any 8-hour work shift of a 40-hour work week to any material in table Z-3 must not exceed the 8-hour time weighted average given in the table. Substances in table Z-3 are measured as mmpcf, or millions of particles per cubic foot of air, based on impinger samples counted by light field technics.

Performing Calculations

The formula for determining an employee's cumulative exposure for any 8-hour work shift is as follows:

$$E = (CaTa + CbTb \times \ldots CnTn) \div 8$$

Where:

E is the equivalent exposure for the working shift. E must at no time exceed the 8-hour time weighted average limit in table Z-1-A, Z-2, or Z-3.

C is the concentration during any period of time T where the concentration remains constant.

T is the duration in hours of the exposure at the concentration C.

For example: From table Z-1 we know the TWA for isoamyl acetate is 100 ppm. Say an employee receives the following exposure:

2 hours at 150 ppm

2 hours at 75 ppm

4 hours at 50 ppm

$$[(2 \times 150) + (2 \times 75) + (4 \times 50)] \div 8 = 81.25$$

The TWA is 81.25 ppm, less than 100 ppm, thus the exposure is acceptable.

If there is a mixture of air contaminants, exposure should be calculated as follows:

$$Em = (C_1 \div L_1 + C_2 \div L_2 + \ldots C_n \div L_n)$$

Where:

Em is the equivalent exposure for the mixture. Em must never exceed unity (1).

C is the concentration of a particular contaminant.

L is the exposure limit for that contaminant, from table Z-1-A, Z-2, or Z-3.

To illustrate the formula prescribed in the previous paragraph, consider the following exposure:

Substance	Actual concentration of 8-hour exposure (ppm)	8 hr. TWA PEL (ppm)
B	500	1,000
C	45	200
D	40	200

Substituting in the formula, we have:
E(m) = 500 divided by 1,000 + 45 divided by 200 + 40 divided by 200
E(m) = 0.500 + 0.225 + 0.200
E(m) = 0.925

Since E(m) is less than 1, the exposure combination is within acceptable limits.

TABLE Z-1-A — Limits For Air Contaminants

Substance	CAS No. (f)	Transitional limits			Final rule limits**						
		PEL*		Skin designation	TWA		STEL (c)		Ceiling		Skin designation
		ppm (a)	mg/m³ (b)		ppm (a)	mg/m³ (b)	ppm (a)	mg/m³ (b)	ppm (a)	mg/m³ (b)	
Acetaldehyde	75-07-0	200	360		100	180	150	270			
Acetic acid	64-19-7	10	25		10	25					
Acetic anhydride	108-24-7	5	20						5	20	
Acetone	67-64-1	1000	2400		750	1,800	1000	2400			
Acetone[h]	67-64-1	1000	2400		750	1,800	1000[h]	2400[h]			
2-Acetylaminofluorine: see 1910.1014	53-96-3										
Acetylene dichloride, see 1,2-Dichloroethylene											
Acetylene tetrabromide	79-27-6	1	14		1	14					
Acetylsalicylic acid (Aspirin)	50-78-2					5					
Acrolein	107-02-8	0.1	0.25		0.1	0.25	0.3	0.3			
Acrylamide	79-06-1		0.3	X		0.03					X
Acrylic acid	79-10-7				10	30					X
Acrylonitrile; see 1910.1045	107-13-1										
Aldrin	309-00-2		0.25	X		0.25					X
Allyl alcohol	107-18-6	2	5	X	2	5	4	10			X
Allyl chloride	107-05-1	1	3		1	3	2	6			
Allyl glycidyl ether (AGE)	106-92-3	(C)10	(C)45		5	22	10	44			
Allyl propyl disulfide	2179-59-1	2	12		2	12	3	18			
alpha-Alumina	1344-28-1										
Total dust			15			10					
Respirable fraction			5								
Aluminum (as Al) Metal	7429-90-5										
Total dust			15			15					
Respirable fraction			5			5					
Pyro powders						5					
Welding fumes***						5					
Soluble salts						2					
Alkyls						2					
4-Aminodiphenyl; see 1910.1011	92-67-1										
2-Aminoethanol, see Ethanolamine											
2-Aminopyridine	504-29-0	0.5	2		0.5	2					
Amitrole	61-82-5					0.2					
Ammonia	7664-41-7	50	35				35	27			
Ammonium chloride fume	12125-02-9					10		20			
Ammonium sulfamate	7773-06-0										
Total dust			15			10					
Respirable fraction			5			5					
n-Amyl acetate	628-63-7	100	525		100	525					
sec-Amyl acetate	626-38-0	125	650		125	650					
Aniline and homologs	62-53-3	5	19	X	2	8					X
Anisidine (o, p-isomers)	29191-52-4		0.5	X		0.5					X
Antimony and compounds (as Sb)	7440-36-0		0.5			0.5					
ANTU (alpha Naphthylthiourea)	86-88-4		0.3			0.3					
Arsenic, organic compounds (as As)	7440-38-2		0.5			0.5					
Arsenic, inorganic compounds (as As); see 1910.1018	7440-38-2										
Arsine	7784-42-1	0.05	0.2		0.05	0.2					
Asbestos; see 1910.1001 and 1910.1101	Varies										
Atrazine	1912-24-9					5					
Azinphos-methyl	86-50-0		0.2	X		0.2					X
Barium, soluble compounds (as Ba)	7440-39-3		0.5			0.5					
Barium sulfate	7727-43-7										
Total dust			15			10					
Respirable fraction			5			5					
Benomyl	17804-35-2										
Total dust			15			10					
Respirable fraction			5			5					
Benzene; see 1910.1028	71-43-2										
See Table Z-2 for the limits applicable in the operations or sectors excluded in 1910.1028[d]											
Benzidine; see 1910.1010	92-87-5										
p-Benzoquinone; see Quinone											
Benzo(a)pyrene; see Coal tar pitch volatiles											
Benzoyl peroxide	94-36-0		5			5					
Benzyl chloride	100-44-7	1	5		1	5					
Beryllium and beryllium compounds (as Be)	7440-41-7		Tbl. Z-2			Tbl. Z-2		Tbl. Z-2		Tbl. Z-2	
Biphenyl, see Diphenyl											
Bismuth telluride, Undoped	1304-82-1										
Total dust			15			15					
Respirable fraction			5			5					
Bismuth telluride, Se-doped						5					
Borates, tetra, sodium salts											
Anhydrous	1330-43-4					10					
Decahydrate	1303-96-4					10					
Pentahydrate	12179-04-3					10					
Boron oxide	1303-86-2										
Total dust			15			10					
Boron tribromide	10294-33-4								1	10	
Boron trifluoride	7637-07-2	(C)1	(C)3						1	3	
Bromacil	314-40-9				1	10					

TABLE Z-1-A — Limits For Air Contaminants — Continued

Substance	CAS No. (f)	Transitional limits			Final rule limits**						
		PEL*		Skin designation	TWA		STEL (c)		Ceiling		Skin designation
		ppm (a)	mg/m³ (b)		ppm (a)	mg/m³ (b)	ppm (a)	mg/m³ (b)	ppm (a)	mg/m³ (b)	
Bromine	7726-95-6	0.1	0.7		0.1	0.7	0.3	2			
Bromine pentafluoride	7789-30-2				0.1	0.7					
Bromoform	75-25-2	0.5	5	X	0.5	5					X
Butadiene (1, 3-Butadiene)	106-99-0	1000	2200		1000	2200					
Butane	106-97-8				800	1900					
Butanethol; see Butyl mercaptan											
2-Butanone (Methyl ethyl ketone)	78-93-3	200	590		200	590	300	885			
2-Butoxyethanol	111-76-2	50	240	X	25	120					X
n-Butyl acetate	123-86-4	150	710		150	710	200	950			
sec-Butyl acetate	105-46-4	200	950		200	950					
tert-Butyl acetate	540-88-5	200	950		200	950					
Butyl acrylate	141-32-2				10	55					
n-Butyl alcohol	71-36-3	100	300						50	150	X
sec-Butyl alcohol	78-92-2	150	450		100	305					
tert-Butyl alcohol	75-65-0	100	300		100	300	150	450			
Butylamine	109-73-9	(C)5	(C)15	X					5	15	X
tert-Butyl chromate (as CrO3)	1189-85-1		(C)0.1	X						0.1	X
n-Butyl glycidyl ether (BGE)	2426-08-6	50	270		25	135					
n-Butyl lactate	138-22-7				5	25					
Butyl mercaptan	109-79-5	10	35		0.5	1.5					
o-sec-Butylphenol	89-72-5				5	30					X
p-tert-Butyltoluene	98-51-1	10	60		10	60	20	120			
Cadmium fume (as Cd)	7440-43-9		Tbl. Z-2			0.1				0.3	
Cadmium dust (as Cd)	7440-43-9		Tbl. Z-2			0.2				0.6	
Cadmium carbonate	1317-65-3										
Total dust			15			15					
Respirable fraction			5			5					
Calcium cyanamide	156-62-7					0.5					
Calcium hydroxide[i]	1305-62-0					5[i]					
Calcium oxide[j]	1305-78-8		5			5[i]					
Calcium silicate	1344-95-2										
Total dust			15			15					
Respirable fraction			5			5					
Calcium sulfate	7778-18-9										
Total dust			15			15					
Respirable fraction			5			5					
Camphor, synthetic	76-22-2		2			2					
Caprolactam	105-60-2										
Dust						1		3			
Vapor					5	20	10	40			
Captafol (Difolatan®)	2425-06-1					0.1					
Captan	133-06-2					5					
Carbaryl (Sevin®)	63-25-2		5			5					
Carbofuran (Furadan®)	1563-66-2					0.1					
Carbon black	1333-86-4		3.5			3.5					
Carbon dioxide	124-38-9	5000*	9000		10,000	18,000	30,000	54,000			
Carbon disulfide	75-15-0	Tbl. Z-2			4	12	12	36			X
Carbon monoxide	630-08-0	50	55		35	40			200	229	
Carbon tetrabromide	558-13-4				0.1	1.4	0.3	4			
Carbon tetrachloride	56-23-5	Tbl. Z-2			2	12.6					
Carbonyl fluoride	353-50-4				2	5	5	15			
Catechol (Pyrocatechol)	120-80-9				5	20					X
Cellulose	9004-34-6										
Total dust			15			15					
Respirable fraction			5			5					
Cesium hydroxide	21351-79-1					2					
Chlordane	57-74-9		0.5	X		0.5					X
Chlorinated camphene	8001-35-2		0.5	X		0.5		1			X
Chlorinated diphenyl oxide	55720-99-5		0.5			0.5					
Chlorine	7782-50-5	(C)1	(C)3		0.5	1.5	1	3			
Chlorine dioxide	10049-04-4	0.1	0.3		0.1	0.3	0.3	0.9			
Chlorine trifluoride	7790-91-2	(C)0.1	(C)0.4						0.1	0.4	
Chloroacetaldehyde	107-20-0	(C)1	(C)3						1	3	
a-Chloroacetophenone (Phenacyl chloride)	532-27-4	0.05	0.3		0.05	0.3					
Chloroacetyl chloride	79-04-9				0.05	0.2					
Chlorobenzene	108-90-7	75	350		75	350					
o-Chlorobenzylidine malononitrile	2698-41-1	0.05	0.4						0.05	0.4	X
Chlorobromomethane	74-97-5	200	1050		200	1050					
2-Chloro-1,3-butadiene; see b-Chloroprene											
Chlorodifluoromethane	75-45-6				1000	3500					
Chlorodiphenyl (42% Chlorine) (PCB)	53469-21-9		1	X		1					X
Chlorodiphenyl (54% Chlorine) (PCB)	11097-69-1		0.5	X		0.5					X
1-Chloro-2,3-epoxypropane; see Epichlorohydrin											
2-Chloroethanol; see Ethylene chlorohydrin											
Chloroethylene; see Vinyl chloride											
Chloroform (Trichloromethane)	67-66-3	(C)50	(C)240		2	9.78					
bis (Cholromethyl) ether; see 1910.1006	542-88-1										

TABLE Z-1-A — Limits For Air Contaminants — Continued

Substance	CAS No. (f)	Transitional limits			Final rule limits**						
		PEL*		Skin designation	TWA		STEL (c)		Ceiling		Skin designation
		ppm (a)	mg/m³ (b)		ppm (a)	mg/m³ (b)	ppm (a)	mg/m³ (b)	ppm (a)	mg/m³ (b)	
Chloromethyl methyl ether; see 1910.1006	107-30-2										
1-Chloro-1-nitropropane	600-25-9	20	100		2	10					
Chloropentafluoroethane	76-15-3				1000	6320					
Chloropicrin	76-06-2	0.1	0.7		0.1	0.7					
beta-Chloroprene	126-99-8	25	90	X	10	35					X
o-Chlorostyrene	2039-87-4				50	285	75	428			
o-Chlorotoluene	95-49-8				50	250					
2-Chloro-6-trichloro-methyl pyridine	1929-82-4										
Total dust			15			15					
Respirable fraction			5			5					
Chlorpyrifos	2921-88-2					0.2					X
Chromic acid and chromates (as CrO_3)	7440-47-3		Tbl. Z-2							0.1	
Chromium (II) compounds (as Cr)	7440-47-3		0.5			0.5					
Chromium (III) compounds (as Cr)	7440-47-3		0.5			0.5					
Chromium metal (as Cr)	7440-47-3		1			1					
Chrysene; see Coal tar pitch volatiles											
Clopidol	2971-90-6										
Total dust			15			15					
Respirable fraction			5			5					
Coal dust (less than 5% SiO_2), Respirable fraction			Tbl. Z-3			2					
Coal dust (greater than or equal to 5% SiO_2), respirable quartz fraction			Tbl. Z-3			0.1					
Coal tar pitch volatiles (benzene soluble fraction), anthracene, BaP, phenanthrene, acridine, chrysene, pyrene	65966-93-2		0.2			0.2					
Cobalt metal, dust, and fume (as Co)	7440-48-4		0.1			0.05					
Cobalt carbonyl (as Co)	10210-68-1					0.1					
Cobalt hydrocarbonyl (as Co)	16842-03-8					0.1					
Coke oven emissions; see 1910.1029											
Copper	7440-50-8										
Fume (as Cu)			0.1			0.1					
Dust and mists (as Cu)			1			1					
Cotton dust (raw)			1			1					

This 8-hour TWA applies to respirable dust as measured by a vertical elutriator cotton dust sampler or equivalent instrument. The time-weighted average applies to the cotton waste processing operations of waste recycling (sorting, blending, cleaning and willowing) and gametting. See also 1910.1043 for cotton dust limits applicable to other sectors.

Substance	CAS No. (f)	PEL* ppm (a)	PEL* mg/m³ (b)	Skin designation	TWA ppm (a)	TWA mg/m³ (b)	STEL (c) ppm (a)	STEL (c) mg/m³ (b)	Ceiling ppm (a)	Ceiling mg/m³ (b)	Skin designation
Crag herbicide (Sesone)	136-78-7										
Total dust			15			10					
Respirable fraction			5			5					
Cresol (all isomers)	1319-77-3	5	22	X	5	22					X
Crotonaldehyde	123-73-9; 4170-30-3	2	6		2	6					
Crufomate	299-86-5										
Cumene	98-82-8					5					
Cyanamide	420-04-2	50	245	X	50	245					X
Cyanides (as CN)	Varies with compound		5			2 5					
Cyanogen	460-19-5										
Cyanogen chloride	506-77-4				10	20					
Cyclohexane	110-82-7	300	1050		300	1050			0.3	0.6	
Cyclohexanol	108-93-0	50	200		50	200					X
Cyclohexanone	108-94-1	50	200		25	100					X
Cyclohexene	110-83-8	300	1015		300	1015					
Cyclohexylamine	108-91-8				10	40					
Cyclonite	121-82-4					1.5					
Cyclopentadiene	542-92-7	75	200		75	200					X
Cyclopentane	287-92-3				600	1720					
Cyhexatin	13121-70-5										
2,4-D (Dichlorylphenoxyacetic acid)	94-75-7					5					
Decaborane	17702-41-9		10			10					
Demeton (Systox®)	8065-48-3	0.05	0.3	X	0.05	0.3	0.15	0.9			X
Dichlorodiphenyltrichloroethane (DDT)	50-29-3		0.1	X		0.1					X
			1	X		1					X
Dichlorvos (DDVP)	62-73-7		1	X		1					X
Diacetone alcohol (4-hydroxy-4-methyl-2-pentanone)	123-42-2	50	240		50	240					
1,2-Diaminoethane; see Ethylenediamine											
Diazinon	333-41-5										
Diazomethane	334-88-3	0.2	0.4		0.2	0.1 0.4					X
Diborane	19287-45-7	0.1	0.1		0.1	0.1					
1,2-Dibromo-3-chloropropane; see 1910.1044	96-12-8										
2-N-Dibutylaminoethanol	102-81-8										
Dibutyl phosphate	107-66-4	1	5		2	14					
Dibutyl phthalate	84-74-2		5		1	5	2	10			
Dichloroacetylene	7572-29-4					5					
o-Dichlorobenzene	95-50-1	(C)50	(C)300						0.1	0.4	
p-Dichlorobenzene	106-46-7	75	450		75	450	110	675	50	300	
3,3'-Dichlorobenzidine; see 1910.1007	91-94-1										

TABLE Z-1-A — Limits For Air Contaminants — Continued

Substance	CAS No. (f)	Transitional limits			Final rule limits**						
		PEL*		Skin designation	TWA		STEL (c)		Ceiling		Skin designation
		ppm (a)	mg/m³ (b)		ppm (a)	mg/m³ (b)	ppm (a)	mg/m³ (b)	ppm (a)	mg/m³ (b)	
Dichlorodifluoromethane	75-71-8	1000	4950		1000	4950					
1,3-Dichloro-5,5-dimethyl hydantoin	118-52-5		0.2			0.2		0.4			
1,1-Dichloroethane	75-34-3	100	400		100	400					
1,2-Dichlorethylene	540-59-0	200	790		200	790					
Dichloroethyl ether	111-44-4	(C)15	(C)90	X	5	30	10	60			X
Dichloromethane; see Methylene chloride											
Dichloromonofluoromethane	75-43-4	1000	4200		10	40					
1,1-Dichloro-1-nitroethane	594-72-9	(C)10	(C)60		2	10					
1,2-Dichloropropane; see Propylenedichloride											
1,3-Dichloropropane	542-75-6				1	5					X
2,2-Dichloropropionic acid	75-99-0				1	6					
Dichlorotetrafluoroethane	76-14-2	1000	7000		1000	7000					
Dicrotophoe	141-66-2					0.25					X
Dicyclopentadiene	77-73-6				5	30					
Dicyclopentadienyl iron	102-54-5										
Total dust			15			10					
Respirable fraction			5			5					
Dieldrin	60-57-1		0.25	X		.025					X
Diethanolamine	111-42-2				3	15					
Diethylamine	109-89-7	25	75		10	30	25	75			
2-Diethylaminoethanol	100-37-8	10	50	X	10	50					X
Diethylene triamine	111-40-0				1	4					
Diethyl ether; see Ethyl ether											
Diethyl ketone	96-22-0				200	705					
Diethyl phthalate	84-66-2					5					
Difluorodibromomethane	75-61-6	100	860		100	860					
Diglycidyl ether (DGE)	2238-07-5	(C)0.5	(C)2.8		0.1	0.5					
Dihydroxybenzene; see Hydroquinone											
Diisobutyl ketone	108-83-8	50	290		25	150					
Diisopropylamine	108-18-9	5	20	X	5	20					X
4-Dimethylaminoazobenzene; see 1910.1015	60-11-7										
Dimethoxymethane; see Methylal											
Dimethyl acetamide	127-19-5	10	35	X	10	35					X
Dimethylamine	124-40-3	10	18		10	18					
Dimethylaminobenzene; see Xylidine											
Dimethylaniline (N-Dimethyl-aniline)	121-69-7	5	25	X	5	25	10	50			X
Dimethylbenzene; see Xylene											
Dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate	300-76-5		3			3					X
Dimethylformamide	68-12-2	10	30	X	10	30					X
2,6-Dimethyl-4-hepta-none; see Diisobutyl ketone											
1,1-Dimethylhydrazine	57-14-7	0.5	1	X	0.5	1					X
Dimethylphthalate	131-11-3		5			5					
Dimethyl sulfate	77-78-1	1	5	X	0.1	0.5					X
Dinitolmide (3,5-Dinitro-o-toluamide)	148-01-6					5					
Dinitrobenzene (all isomers)	(alpha-) 528-29-0		1	X		1					X
	(meta-) 99-65-0										
	(para-) 100-25-1										
Dinitro-o-cresol	534-52-1		0.2	X		0.2					X
Dinitrotoluene	25321-14-6		1.5	X		1.5					X
Dioxane (Diethylene dioxide)	123-91-1	100	360	X	25	90					X
Dioxathion (Delnav)	78-34-2					0.2					X
Diphenyl (Biphenyl)	92-52-4	0.2	1		0.2	1					
Diphenylamine	122-39-4					10					
Diphenylmethane diisocyanate, see Methylene bisphenyl isocyanate											
Dipropylene glycol methyl ether	34590-94-8	100	600	X	100	600	150	900			X
Dipropyl ketone	123-19-3				50	235					
Diquat	85-00-7					0.5					
Di-sec. octyl phthalate (Di-2-ethylhexyl-phthalate)	117-81-7		5			5		10			
Disulfiram	97-77-8					2					
Disulfoton	298-04-4					0.1					X
2,6-Di tert-butyl p-cresol	128-37-0					10					
Diuron	330-54-1					10					
Divinyl benzene	1321-74-0				10	50					
Emery	112-62-9										
Total dust			15			10					
Respirable fraction			5			5					
Endosulfan	115-29-7					0.1					X
Endrin	72-20-8		0.1	X		0.1					X
Epichlorhydrin	106-89-8	5	19	X	2	8					X
EPN	2104-64-5		0.5	X		0.5					X
1,2-Epoxypropane, see Propylene oxide											
2,3-Epoxy-1-propanol; see Glycidol											
Ethanethiol; see Ethyl mercaptan											
Ethanolamine	141-43-5	3	6		3	8	6	15			

TABLE Z-1-A — Limits For Air Contaminants — Continued

Substance	CAS No. (f)	Transitional limits			Final rule limits**						
		PEL*		Skin designation	TWA		STEL (c)		Ceiling		Skin designation
		ppm (a)	mg/m³ (b)		ppm (a)	mg/m³ (b)	ppm (a)	mg/m³ (b)	ppm (a)	mg/m³ (b)	
Ethion	563-12-2					0.4					X
2-Ethoxyethanol	110-80-5	200	740	X	200	740					X
2-Ethoxyethylacetate (Cellosolve acetate)	111-15-9	100	540	X	100	540					X
Ethyl acetate	141-78-6	400	1400		400	1400					
Ethyl acrylate	140-88-5	25	100	X	5	20	25	100			X
Ethyl alcohol (Ethanol)	64-17-5	1000	1900		1000	1900					
Ethylamine	75-04-7	10	18		10	18					
Ethyl amyl ketone (5-Methyl-3-heptanone)	541-85-5	25	130		25	130					
Ethyl benzene	100-41-4	100	435		100	435	125	545			
Ethyl bromide	74-96-4	200	890		200	890	250	1110			
Ethyl butyl ketone (3-Heptanone)	106-35-4	50	230		50	230					
Ethyl chloride	75-00-3	1000	2600		1000	2600					
Ethyl ether	60-29-7	400	1200		400	1200	500	1500			
Ethyl formate	109-94-4	100	300		100	300					
Ethyl mercaptan	75-08-1	(C)10	(C)25		0.5	1					
Ethyl silicate	78-10-4	100	850		10	85					
Ethylene chlorohydrin	107-07-3	5	16	X					1	3	X
Ethylenediamine	107-15-3	10	25		10	25					
Ethylene dibromide	106-93-4	Tbl. Z-2	Tbl. Z-2	Tbl. Z-2	Tbl. Z-2	Tbl. Z-2	Tbl. Z-2	Tbl. Z-2	Tbl. Z-2	Tbl. Z-2	Tbl. Z-2
Ethylene dichloride	107-06-2	Tbl. Z-2	Tbl. Z-2	Tbl. Z-2	1	4	2	8			
Ethylene glycol	107-21-1								50	125	
Ethylene glycol dinitrate[k]	628-96-6	(C)0.2	(C)1	X				[k]0.1			X
Ethylene glycol methyl acetate; see Methyl cellosolve acetate											
Ethyleneimine; see 1910.1012	151-56-4										
Ethylene oxide; see 1910.1047	75-21-8										
Ethylidine chloride; see 1,1-Dichloroethane											
Ethylidene norbornene	16219-75-3								5	25	
N-Ethylmorpholine	100-74-3	20	94	X	5	23					X
Fenamiphos	22224-92-6					0.1					X
Fensulfothion (Dasanit)	115-90-2					0.1					
Fenthion	55-38-9					0.2					X
Ferbam	14484-64-1										
Total dust			15			10					
Ferrovanadium dust	12604-58-9		1			1		3			
Fluoride (as F)	Varies with compound		2.5			2.5					
Fluorine	7782-41-4	0.1	0.2		0.1	0.2					
Fluorotrichloromethane (Trichlorofluoromethane)	75-69-4	1000	5800						1000	5600	
Fonofos	944-22-9					0.1					X
Formaldehyde; see 1910.1048; see Table Z-2 for operations or sectors excluded from 1910.1048 or for which limit(s) is (are) stayed	50-00-0										
Formamide	75-12-7				20	30	30	45			
Formic acid	64-18-6	5	9		5	9					
Furfural	96-01-1	5	20	X	2	8					X
Furfuryl alcohol	96-00-0	50	200		10	40	15	60			X
Gasoline	8006-61-9				300	900	500	1500			
Germanium tetrahydride	7782-65-2				0.2	0.6					
Glutaraldehyde	111-30-8								0.2	0.8	
Glycerin (mist)	56-81-5										
Total dust			15			10					
Respirable fraction			5			5					
Glycidol	556-52-5	50	150		25	75					
Glycol monoethyl ether; see 2-Ethoxyethanol											
Grain dust (oat, wheat, barley)						10					
Graphite, natural respirable dust	7782-42-5		Tbl. Z-3			2.5					
Graphite, synthetic											
Total dust			15			10					
Respirable fraction			5			5					
Guthion[R]; see Azinphos methyl											
Gypsum	13397-24-5										
Total dust			15			10					
Respirable fraction			5			5					
Hafnium	7440-58-6		0.5			0.5					
Heptachlor	76-44-8		0.5	X		0.5					X
Heptane (n-Heptane)	142-82-5	500	2000		400	1600	500	2000			
Hexachlorobutadiene	87-68-3				0.02	0.24					
Hexachlorocyclo-pentadiene	77-47-4				0.01	0.1					
Hexachloroethane	67-72-1	1	10	X	1	10					X
Hexachloronaphthalene	1335-87-1		0.2	X		0.2					X
Hexafluoroacetone	684-16-2				0.1	0.7					X
n-Hexane	110-54-3	500	1800		50	180					
Hexane isomers	Varies with compound				500	1800	1000	3600			
2-Hexanone (Methyl n-butyl ketone)	591-78-6	100	410		5	20					
Hexone (Methyl isobutyl ketone)	108-10-1	100	410		50	205	75	300			⅛

TABLE Z-1-A — Limits for Air Contaminants — Continued

Substance	CAS No. (f)	Transitional limits			Final rule limits**						
		PEL*		Skin designation	TWA		STEL (c)		Ceiling		Skin designation
		ppm (a)	mg/m³ (b)		ppm (a)	mg/m³ (b)	ppm (a)	mg/m³ (b)	ppm (a)	mg/m³ (b)	
sec-Hexyl acetate	108-84-9	50	300		50	300					
Hexylene glycol	107-41-5								25	125	
Hydrazine	302-01-2	1	1.3	X	0.1	0.1					X
Hydrogenated terphenyls	61788-32-7				0.5	5					
Hydrogen bromide	10035-10-6	3	10						3	10	
Hydrogen chloride	7647-01-0	(C)5	(C)7						5	7	
Hydrogen cyanide	74-90-8	10	11	X			4.7	5			X
Hydrogen fluoride (as F)	7664-39-3	Tbl. Z-2			3		6				
Hydrogen peroxide	7722-84-1	1	1.4		1	1.4					
Hydrogen selenide (as Se)	7783-07-5	0.05	0.2		0.05	0.2					
Hydrogen sulfide	7783-06-4	Tbl. Z-2	Tbl. Z-2		10	14	15	21			
Hydroquinone	123-31-9		2			2					
2-Hydroxypropyl acrylate	999-61-1				0.5	3					X
Indene	95-13-6				10	45					
Indium and compounds (as In)	7440-74-6					0.1					
Iodine	7553-56-2	(C)0.1	(C)1						0.1	1	
Iodoform	75-47-8				0.6	10					
Iron oxide fume	1309-37-1			10			10				
Iron pentacarbonyl (as Fe)	13463-40-6				0.1	0.8	0.2	1.6			
Iron salts (soluble) (as Fe)	Varies with compound					1					
Isoamyl acetate	123-92-2	100	525		100	525					
Isoamyl alcohol (primary and secondary)	123-51-3	100	360		100	360	125	450			
Isobutyl acetate	110-19-0	150	700		150	700					
Isobutyl alcohol	78-83-1	100	300		50	150					
Isooctyl alcohol	26952-21-6				50	270					X
Isophorone	78-59-1	25	140		4	23					
Isophorone diisocyanate	4098-71-9				0.005		0.02				X
2-Isopropoxyethanol	109-59-1				25	105					
Isopropyl acetate	108-21-4	250	950		250	950	310	1185			
Isopropyl alcohol	67-63-0	400	980		400	980	500	1225			
Isopropylamine	75-31-0	5	12		5	12	10	24			
N-Isopropylaniline	768-52-5				2	10					X
Isopropyl ether	108-20-3	500	2100		500	2100					
Isopropyl glycidyl ether (IGE)	4016-14-2	50	240		50	240	75	360			
Kaolin											
Total dust			15			10					
Respirable fraction			5			5					
Ketene	463-51-4	0.5	0.9		0.5	0.9	1.5	3			
Lead inorganic (as Pb); see 1910.1025	7439-92-1										
Limestone	1317-65-3										
Total dust			15			15					
Respirable fraction			5			5					
Lindane	58-89-9		0.5	X		0.5					X
Lithium hydride	7580-67-8		0.025			0.025					
L.P.G. (liquefied petroleum gas)	68476-85-7	1000	1800		1000	1800					
Magnesite	546-93-0										
Total dust			15			15					
Respirable fraction			5			5					
Magnesium oxide fume	1309-48-4										
Total particulate			15			10					
Malathion	121-75-5										
Total dust			15	X		10					X
Maleic anhydride	108-31-6	0.25	1		0.25	1					
Manganese compounds (as Mn)	7439-96-5		(C)5							5	
Manganese fume (as Mn)	7439-96-5		(C)5			1		3			
Manganese cyclopenta-dienyl tricarbonyl (as Mn)	12079-65-1					0.1					X
Manganese tetroxide (as Mn)	1317-35-7					1					
Marble	1317-65-3										
Total dust			15			15					
Respirable fraction			5			5					
Mercury (aryl and inorganic) (as Hg)	7439-97-6		Tbl. Z-2							0.1	X
Mercury (organo) alkyl compounds (as Hg)	7349-97-6		Tbl. Z-2			0.01		0.03			X
Mercury (vapor) (as Hg)	7439-97-6		Tbl. Z-2			0.05					X
Mesityl oxide	141-79-7	25	100		15	60	25	100			
Methacrylic acid	79-41-4				20	70					X
Methanethiol; see Methyl mercaptan											
Methomyl (Lannate)	16752-77-5					2.5					
Methoxychlor	72-43-5										
Total dust			15			10					
2-Methoxyethanol; see Methyl cellosolve											
4-Methoxyphenol	150-76-5					5					
Methyl acetate	79-20-9	200	610		200	610	250	760			
Methyl acetylene (Propyne)	74-99-7	1000	1650		1000	1650					
Methyl acetylene-propadiene mixture (MAPP)		1000	1800		1000	1800	1250	2250			
Methyl acrylate	96-33-3	10	35	X	10	35					X

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TABLE Z-1-A — Limits For Air Contaminants — Continued

Substance	CAS No. (f)	Transitional limits			Final rule limits**						
		PEL*		Skin designation	TWA		STEL (c)		Ceiling		Skin designation
		ppm (a)	mg/m³ (b)		ppm (a)	mg/m³ (b)	ppm (a)	mg/m³ (b)	ppm (a)	mg/m³ (b)	
Methyl amyl alcohol; see Methyl isobutyl carbinol											
Methyl n-amyl ketone	110-43-0	100	465		100	465					
Methyl bromide	74-83-9	(C)20	(C)80	X	5	20					X
Methyl butyl ketone; see 2-Hexanone											
Methyl cellosolve (2-Methoxyethanol)	109-86-4	25	80	X	25	80					X
Methyl cellosolve acetate (2-Methoxyethyl acetate)	110-49-6	25	120	X	25	120					X
Methyl chloride	74-87-3	Tbl. Z-2			50	105	100	210			
Methyl chloroform (1,1,1-Trichloroethane)	71-55-6	350	1900		350	1900	450	2450			
Methyl 2-cyanoacrylate	137-05-3				2	8	4	16			
Methyl cyclohexane	108-87-2	500	2000		400	1600					
Methylcyclohexanol	25639-42-3	100	470		50	235					
o-Methylcyclohexanone	583-60-8	100	460	X	50	230	75	345			X
Methylcyclopentadienyl manganese tricarbonyl (as Mn)	12108-13-3					0.2					X
Methyl demeton	8022-00-2					0.5					X
4,4'-Methylene bis (2-chloroaniline) (MBOCA)	101-14-4				0.02	0.22					X
Methylene bis (4-cyclohexylisocyanate)	5124-30-1								0.01	0.11	X
Methylene chloride	75-09-2	Tbl. Z-2			Tbl. Z-2		Tbl. Z-2		Tbl. Z-2		
Methyl ethyl ketone peroxide (MEKP)	1338-23-4								0.7	5	
Methyl formate	107-31-3	100	250		100	250	150	375			
Methyl hydrazine (Monomethyl hydrazine)	60-34-4	(C)0.2	(C)0.35	X					0.2	0.35	X
Methyl iodide	74-88-4	5	28	X	2	10					X
Methyl isoamyl ketone	110-12-3				50	240					
Methyl isobutyl carbinol	108-11-2	25	100	X	25	100	40	165			X
Methyl isobutyl ketone, see Hexone											
Methyl isocyanate	624-83-9	0.02	0.05	X	0.02	0.05					X
Methyl isopropyl ketone	563-80-4				200	705					
Methyl mercaptan	74-93-1	(C)10	(C)20		0.5	1					
Methyl methacrylate	80-62-6	100	410		100	410					
Methyl parathion	298-00-0					0.2					X
Methyl propyl ketone; see 2-Pentanone											
Methyl silicate	681-84-5				1	6					
alpha-Methyl styrene	98-83-9	(C)100	(C)480		50	240	100	485			
Methylene bisphenyl isocyanate (MDI)	101-68-8	(C)0.02	(C)0.2						0.02	0.2	
Metribuzin	21087-64-9					5					
Mica; see Silicates											
Molybdenum (as Mo)	7439-98-7										
Soluble compounds			5			5					
Insoluble compounds											
Total dust			15			10					
Monocrotophos (Azodrin®)	6923-22-4					0.25					
Monomethyl aniline	100-61-8	2	9	X	0.5	2					X
Morpholine	110-91-8	20	70	X	20	70	30	105			X
Naphtha (coal tar)	8030-30-6	100	400		100	400					
Naphthalene	91-20-3	10	50		10	50	15	75			
alpha-Naphthylamine; see 1910.1004	134-32-7										
beta-Naphthylamine; see 1910.1009	91-59-8										
Nickel carbonyl (as Ni)	13463-39-3	0.001	0.007		0.001	0.007					
Nickel, metal and insoluble compounds (as Ni)	7440-02-0		1			1					
Nickel, soluble compounds (as Ni)	7440-02-0		1			0.1					
Nicotine	54-11-5		0.5	X		0.5					X
Nitric acid	7697-37-2	2	5		2	5	4	10			
Nitric oxide	10102-43-9	25	30		25	30					
p-Nitroaniline	100-01-6	1	6	X		3					X
Nitrobenzene	98-95-3	1	5	X	1	5					X
p-Nitrochlorobenzene	100-00-5		1	X		1					X
4-Nitrodiphenyl; see 1910.1003	92-93-3										
Nitroethane	79-24-3	100	310		100	310					
Nitrogen dioxide	10102-44-0	(C)5	(C)9				1	1.8			
Nitrogen trifluoride	7783-54-2	10	29		10	29					
Nitroglycerin[1]	55-63-0	(C)0.2	(C)2	X				[1]0.1			X
Nitromethane	75-52-5	100	250		100	250					
1-Nitropropane	108-03-2	25	90		25	90					
2-Nitropropane	79-46-9	25	90		10	35					
N-Nitrosodimethylamine; see 1910.1016	62-79-9										
Nitrotoluene		5	30	X	2	11					X
o-isomer	88-72-2										
m-isomer	99-08-1										
p-isomer	99-99-0										
Nitrotrichloromethane; see Chloropicrin											
Nonane	111-84-2				200	1050					
Octachloronaphthalene	2234-13-1		0.1	X		0.1		0.3			X
Octane	111-65-9	500	2350		300	1450	375	1800			

TABLE Z-1-A — Limits For Air Contaminants — Continued

Substance	CAS No. (f)	Transitional limits			Final rule limits**						
		PEL*		Skin designation	TWA		STEL (c)		Ceiling		Skin designation
		ppm (a)	mg/m³ (b)		ppm (a)	mg/m³ (b)	ppm (a)	mg/m³ (b)	ppm (a)	mg/m³ (b)	
Oil mist, mineral	8012-95-1		5			5					
Osmium tetroxide (as Os)	20816-12-0		0.002		0.0002	0.002	0.0006	0.006			
Oxalic acid	144-62-7		1			1		2			
Oxygen difluoride	7783-41-7	0.05	0.1						0.05	0.1	
Ozone	10028-15-6	0.1	0.2		0.1	0.2	0.3	0.6			
Paraffin wax fume	8002-74-2					2					
Paraquat, respirable dust	1910-42-5 4685-14-7 2074-50-2		0.5	X		0.1					X
Parathion	56-38-2		0.1	X		0.1					X
Particulates not otherwise regulated											
Total dust			15			15					
Respirable fraction			5			5					
Pentaborane	19624-22-7	0.005	0.01		0.005	0.01	0.015	0.03			
Pentachloronaphthalene	1321-64-8		0.5	X		0.5					X
Pentachlorophenol	87-86-5		0.5	X		0.5					X
Pentaerythritol	115-77-5										
Total dust			15			10					
Respirable fraction			5			5					
Pentane	109-66-0	1000	2950		600	1800	750	2250			
2-Pentanone (Methyl propyl ketone)	107-87-9	200	700		200	700	250	875			
Perchloromethylene (Tetrachloroethylene)	127-18-4	Tbl. Z-2			25	170					
Perchloromethyl mercaptan	594-42-3	0.1	0.8		0.1	0.8					
Perchloryl fluoride	7616-94-6	3	13.5		3	14	6	28			
Perlite											
Total dust			15			15					
Respirable fraction			5			5					
Petroleum distillates (Naphtha)(Rubber Solvent)		500	2000		400	1600					
Phenol	108-95-2	5	19	X	5	19					X
Phenothiazine	92-84-2					5					X
p-Phenylene diamine	106-50-3		0.1	X		0.1					X
Phenyl ether, vapor	101-84-8	1	7		1	7					
Phenyl ether-biphenyl mixture, vapor		1	7		1	7					
Phenylethylene; see Styrene											
Phenyl glycidyl ether (PGE)	122-60-1	10	60		1	6					
Phenylhydrazine	100-63-0	5	22	X	5	20	10	45			X
Phenyl mercaptan	108-98-5				0.5	2					
Phenylphosphine	638-21-1								0.05	0.25	
Phorate	298-02-2					0.05		0.2			X
Phosdrin (Mevinphos[R])	7786-34-7		0.1	X	0.01	0.1	0.03	0.3			X
Phosgene (Carbonyl chloride)	75-44-5	0.1	0.4		0.1	0.4					
Phosphine	7803-51-2	0.3	0.4		0.3	0.4	1	1			
Phosphoric acid	7664-38-2		1			1		3			
Phosphorus (yellow)	7723-14-0		0.1			0.1					
Phosphorus oxychloride	10025-87-3				0.1	0.6					
Phosphorus pentachloride	10026-13-8		1			1					
Phosphorus pentasulfide	1314-80-3		1			1		3			
Phosphorus trichloride	7719-12-2	0.5	3		0.2	1.5	0.5	3			
Phthalic anhydride	85-44-9	2	12		1	6					
m-Phthalodinitrile	626-17-5					5					
Picloram	1918-02-1										
Total dust			15			10					
Respirable fraction			5			5					
Picric acid	88-89-1		0.1	X		0.1					X
Piperazine dihydro-chloride	142-64-3					5					
Pindone (2-Pivalyl-1,3-indandione)	83-26-1		0.1			0.1					
Plaster of Paris	26499-65-0										
Total dust			15			15					
Respirable fraction			5			5					
Platinum (as Pt)	7440-06-4										
Metal						1					
Soluble salts			0.002			0.002					
Portland cement	65997-15-1										
Total dust			Tbl. Z-3			10					
Respirable fraction			Tbl. Z-3			5					
Potassium hydroxide	1310-58-3									2	
Propane	74-98-6	1000	1800		1000	1800					
Propargyl alcohol	107-19-7				1	2					X
beta-Propriolactone; see 1910.1013	57-57-8										
Propionic acid	79-09-4				10	30					
Propoxur (Baygon)	114-26-1					0.5					
n-Propyl acetate	109-60-4	200	840		200	840	250	1050			
n-Propyl alcohol	71-23-8	200	500		200	500	250	625			
n-Propyl nitrate	627-13-4	25	110		25	105	40	170			
Propylene dichloride	78-87-5	75	350		75	350	110	510			
Propylene glycol dinitrate	6423-43-4				0.05	0.3					

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TABLE Z-1-A — Limits For Air Contaminants — Continued

Substance	CAS No. (f)	Transitional limits			Final rule limits**						
		PEL*		Skin designation	TWA		STEL (c)		Ceiling		Skin designation
		ppm (a)	mg/m³ (b)		ppm (a)	mg/m³ (b)	ppm (a)	mg/m³ (b)	ppm (a)	mg/m³ (b)	
Propylene glycol monomethyl ether	107-98-2				100	360	150	540			
Propylene imine	75-55-8	2	5	X	2	5					X
Propylene oxide	75-56-9	100	240		20	50					
Propyne: see Methyl acetylene											
Pyrethrum	8003-34-7		5			5					
Pyridine	110-86-1	5	15		5	15					
Quinone	106-51-4	0.1	0.4		0.1	0.4					
Resorcinol	108-46-3				10	45	20	90			
Rhodium (as Rh), metal fume and insoluble compounds	7440-16-6		0.1			0.1					
Rhodium (as Rh), soluble compounds	7440-16-6		0.001			0.001					
Ronnel	299-84-3		15			10					
Rosin core solder pyrolysis products, as formaldehyde						0.1					
Rotenone	83-79-4		5			5					
Rouge											
Total dust			15			10					
Respirable fraction			5			5					
Selenium compounds (as Se)	7782-49-2		0.2			0.2					
Selenium hexafluoride (as Se)	7783-79-1	0.05	0.4		0.05	0.4					
Silica, amorphous, precipitated and gel	112926-00-8		Tbl. Z-3			6					
Silica, amorphous, diatomaceous earth, containing less than 1% crystalline silica.											
Silica, crystalline cristobalite, respirable dust	14464-46-1		Tbl. Z-3			0.05					
Silica, crytalline quartz, respirable dust	14808-60-7		Tbl. Z-3			0.1					
Silica, crystalline tripoli (as quartz), respirable dust	1317-95-5		Tbl. Z-3			0.1					
Silica, crytalline tridymite, respirable dust	15468-32-2		Tbl. Z-3			0.05					
Silica, fused, respirable dust	60676-86-0		Tbl. Z-3			0.1					
Silicates (less than 1% crytalline silica)											
Mica (respirable dust)	12001-26-2		Tbl. Z-3			3					
Soapstone, total dust			Tbl. Z-3			6					
Soapstone, respirable dust			Tbl. Z-3			3					
Talc (containing asbestos): use asbestos limit See 29 CFR 1910.1001			Tbl. Z-3								
Talc (containing no asbestos), respirable dust	14807-96-6		Tbl. Z-3			2					
Tremolite See 29 CFR 1910.1101			Tbl. Z-3								
Silicon	7440-21-3										
Total dust			15			10					
Respirable fraction			5			5					
Silicon carbide	409-21-2										
Total dust			15			10					
Respirable fraction			5			5					
Silicon tetrahydride	7803-62-5				5	7					
Silver, metal and soluble compounds (as Ag)	7440-22-4		0.01			0.01					
Soapstone: see Silcates											
Sodium azide	26628-22-8										
(as HN_3)									0.1		X
(as NaN_3)										0.3	X
Sodium bisulfite	7631-90-5					5					
Sodium fluoroacetate	62-74-8		0.05	X		0.05		0.15			X
Sodium hydroxide	1310-73-2		2							2	
Sodium metabisulfite	7681-57-4					5					
Starch	9005-25-8										
Total dust			15			15					
Respirable fraction			5			5					
Stibine	7803-52-3	0.1	0.5		0.1	0.5					
Stoddard solvent	8052-41-3	500	2900		100	525					
Strychnine	57-24-9		0.15			0.15					
Styrene	100-42-5	Tbl. Z-2			50	215	100	425			
Subtilisins (Proteolytic enzymes)	9014-01-1							0.00006 (60 min.)[8]			
Sucrose											
Total dust	57-50-1										
Respirable fraction			15			15					
Sulfur dioxide			5			5					
Sulfur hexafluoride	7446-09-5	5	13		2	5	5	13			
	2551-62-4	1000	6000		1000	6000					
Sulfuric acid	7664-93-9		1			1					
Sulfur monochloride	10025-67-9	1	6						1	6	
Sulfur pentafluoride	5714-22-7	0.025	0.25						0.01	0.1	
Sulfur tetrafluoride	7783-60-0								0.1	0.4	
Sulfuryl fluoride	2699-79-8	5	20		5	20	10	40			
Sulprofos	35400-43-2					1					
Systox[R], see Demeton											
2,4,5-T	93-76-5		10			10					
Talc: see Silicates											
Tantalum, metal and oxide dust	7440-25-7		5			5					
TEDP (Sulfotep)	3689-24-5		0.2	X		0.2					X
Tellurium and compounds (as Te)	13494-80-9		0.1			0.1					
Tellurium hexafluoride (as Te)	7783-80-4	0.02	0.2		0.02	0.2					

TABLE Z-1-A — Limits For Air Contaminants — Continued

Substance	CAS No. (f)	Transitional limits			Final rule limits**						
		PEL*		Skin designation	TWA		STEL (c)		Ceiling		Skin designation
		ppm (a)	mg/m³ (b)		ppm (a)	mg/m³ (b)	ppm (a)	mg/m³ (b)	ppm (a)	mg/m³ (b)	
Temephos	3383-96-8										
Total dust			15			10					
Respirable fraction			5			5					
TEPP	107-49-3		0.05	X		0.05					X
Terphenyls	26140-60-3	(C)1	(C)9						0.5	5	
1,1,1,2-Tetrachloro-2,2-difluoroethane	76-11-9	500	4170		500	4170					
1,1,2,2-Tetrachloro-1,2-difluoroethane	76-12-0	500	4170		500	4170					
1,1,2,2-Tetrachloroethane	79-34-5	5	35	X	1	7					X
Tetrachoroethylene; see Perchloroethylene											
Tetrachloromethane, see Carbon tetrachloride											
Tetrachloronaphthalene	1335-88-2		2	X		2					X
Tetraethyl lead (as Pb)	78-00-2		0.075	X		0.075					X
Tetrahydrofuran	109-99-9	200	590		200	590	250	735			
Tetramethyl lead (as Pb)	75-74-1		0.075	X		0.075					X
Tetramethyl succinonitrile	3333-52-6	0.5	3	X	0.5	3					X
Tetranitromethane	509-14-8	1	8		1	8					
Tetrasodium pyrophosphate	7722-88-5					5					
Tetryl (2,4,6-Trinitrophenyl-methyl-nitramine)	479-45-8		1.5	X		1.5					X
Thallium, soluble compounds (as Tl)	7440-28-0		0.1	X		0.1					X
4,4'-Thiobis (6-tert, Butyl-m-cresol)	96-69-5										
Total dust			15			10					
Respirable fraction			5			5					
Thioglycolic acid	68-11-1				1	4					X
Thionyl chloride	7719-09-7								1	5	
Thiram	137-26-8		5			5					
Tin, inorganic compounds (except oxides) (as Sn)	7440-31-5		2			2					
Tin, organic compounds (as Sn)	7440-31-5		0.1			0.1					X
Tin oxide (as Sn)	21651-19-4					2					
Titanium dioxide	13463-67-7										
Total dust			15			10					
Toluene	108-88-3	Tbl. Z-2			100	375	150	560			
Toluene-2,4-diisocyanate (TDI)	584-84-9	(C)0.02	(C)0.14		0.005	0.04	0.02	0.15			
m-Toluidine	108-44-1				2	9					X
o-Toluidine	95-53-4	5	22	X	5	22					X
p-Toluidine	106-49-0				2	9					X
Toxaphene; see Chlorinated camphene											
Tremolite; see Silicates											
Tributyl phosphate	126-73-8		5		0.2	2.5					
Trichloroacetic acid	76-03-9				1	7					
1,2,4-Trichlorobenzene	120-82-1								5	40	
1,1,1,-Trichloroethane; see Methyl chloroform											
1,1,2-Trichloroethane	79-00-5	10	45	X	10	45					X
Trichloroethylene	79-01-6	Tbl. Z-2	Tbl. Z-2	Tbl. Z-2	50	270	200	1080			
Trichloromethane; see Chloroform											
Trichloronaphthalene	1321-65-9		5	X		5					X
1,2,3-Trichloropropane	96-18-4	50	300		10	60					
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	1000	7600		1000	7600	1250	9500			
Triethylamine	121-44-8	25	100		10	40	15	60			
Trifluorobromomethane	75-63-8	1000	6100		1000	6100					
Trimellitic anhydride	552-30-7				0.005	0.04					
Trimethylamine	75-50-3				10	24	15	36			
Trimethyl benzene	25551-13-7				25	125					
Trimethyl phosphite	121-45-9				2	10					
2,4,6-Trinitrophenyl; see Picric acid											
2,4,6-Trinitrophenylmethyl nitramine; see Tetryl											
2,4,6-Trinitrotoluene (TNT)	118-96-7		1.5	X		0.5					X
Triorthocresyl phosphate	78-30-8		0.1			0.1					X
Triphenyl amine	603-34-9					5					
Triphenyl phosphate	115-86-6		3			3					
Tungsten (as W)	7440-33-7										
Insoluble compounds						5		10			
Soluble compounds						1		3			
Turpentine	8006-64-2	100	560		100	560					
Uranium (as U)	744-61-1										
Soluble compounds			0.05			0.05					
Insoluble compounds			0.25			0.2		0.6			
n-Valeraldehyde	110-62-3				50	175					
Vanadium	1314-62-1										
Respirable dust (as V_2O_3)			(C)0.5			0.05					
Fume (as V_2O_3)			(C)0.1			0.05					
Vegetable oil mist											
Total dust			15			15					
Respirable fraction			5			5					
Vinyl acetate	108-05-4				10	30	20	60			
Vinyl benzene; see Styrene											
Vinyl bromide	593-60-2				5	20					
Vinyl chloride; see 1910.1017	75-01-4										
Vinyl cyanide; see Acrylonitrile											
Vinyl cyclohexene dioxide	106-87-6				10	60					X

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TABLE Z-1-A — Limits Air Contaminants — Continued

Substance	CAS No. (f)	Transitional limits			Final rule limits**						
		PEL*		Skin designation	TWA		STEL (c)		Ceiling		Skin designation
		ppm (a)	mg/m³ (b)		ppm (a)	mg/m³ (b)	ppm (a)	mg/m³ (b)	ppm (a)	mg/m³ (b)	
Vinylidene chloride (1.1-Dichloroethylene)	75-35-4				1	4					
Vinyl toluene	25013-15-4	100	480		100	480					
VM & P Naphtha	8032-32-4				300	1350	400	1800			
Warfarin	81-81-2		0.1			0.1					
Welding fumes (total particulate)***						5					
Wood dust, all soft and hard woods, except Western red cedar						5		10			
Wood dust, Western red cedar						2.5					
Xylenes (o-, m-, p-, isomers)	1330-20-7	100	435		100	435	150	655			
m-Xylene alpha, alpha'- diamine	1477-55-0									0.1	X
Xylidine	1300-73-8	5	25	X	2	10					X
Yttrium	7440-65-5		1			1					
Zinc chloride fume	7646-85-7		1			1		2			
Zinc chromate (as CrO_3)	Varies with compound	Tbl. Z-2	Tbl. Z-2	Tbl. Z-2						0.1	
Zinc oxide fume	1314-13-2		5			5		10			
Zinc oxide	1314-13-2										
Total dust			15			10					
Respirable fraction			5			5					
Zinc stearate	577-05-1										
Total dust			15			10					
Respirable fraction			5			5					
Zirconium compounds (as Zr)	7440-67-7		5			5		10			

* The transitional PELs are 8-hour TWAs unless otherwise noted; a (C) designation denotes a ceiling limit.

** Unless otherwise noted, employers in General Industry (i.e., those covered by 29 CFR 1910) may use any combination of controls to achieve these limits until Dec. 31, 1993 as set forth in 29 CFR 1910.1000(f).

*** As determined from breathing-zone air samples.

(a) Parts of vapor or gas per million parts of contaminated air by volume at 25° C and 760 torr.

(b) Milligrams of substance per cubic meter of air. When a numerical entry for a substance is in the mg/m³ column and not in the ppm column, then the number in the mg/m³ column is exact. When numerical entries for a substance are in both the ppm and mg/m³ column, then the number in the ppm column is exact and the number in the mg/m³ column may be rounded off.

(c) Duration is for 15 minutes, unless otherwise noted.

(d) The final benzene standard in 1910.1028 applies to all occupational exposures to benzene except some subsegments of industry where exposures are consistently under the action level (i.e., distribution and sale of fuels, sealed containers and pipelines, coke production, oil and gas drilling and production, natural gas processing, and the percentage exclusion for liquid mixtures); for the excepted subsegments, the benzene limit in Table Z-2 apply.

(e) Exposures under 10,000 ppm to be cited de minimus.

(f) The CAS number is for information only. Enforcement is based on the substance name. For an entry covering more than one metal compound measured as the metal, the CAS number for the metal is given — not the CAS numbers for the individual compounds.

(g) Compliance with the subtilisins PEL is assessed by sampling with a high volume sampler (600-800 liters per minute) for at least 60 minutes.

(h) The acetone STEL does not apply to the cellulose acetone fiber industry. It is in effect for all other sectors.

(i) The Final Rule Limit of 5mg/m³ is not in effect as a result of reconsideration. Calcium hydroxide is covered by the exposure limits for particulates not otherwise regulated of 5 mg/m³ respirable dust and 15 mg/m³ total dust.

(j) The Final Rule Limit TWA of 5 mg/m³ is not in effect as a result of reconsideration. The calcium oxide Transitional Limit of 5 mg/m³ remains in effect and employee exposures shall be kept below that level pursuant to the methods of compliance specified in 29 CFR 1910.1000(e).

(k) The Final Rule Limit STEL of 0.1 mg/m³ is not in effect as a result of reconsideration for the industrial sector of civilian manufacture and distribution of explosives and propellants for civilian use. The Final rule limits skin designation and the Transitional limits ceiling limit of 1 mg/m³ remain in effect for this sector until completion of the reconsideration.

(l) The Final Rule Limit STEL of 0.1 mg/m³ is not in effect as a result of reconsideration for the industrial sector of civilian manufacture and distribution of explosives and propellants for civilian use. The Final rule limits skin designation and the Transitional limits ceiling limit of 2 mg/m³ remain in effect for this sector until completion of the reconsideration.

(m) Sampling for the carbon monoxide ceiling shall be averaged over 5 minutes but an instantaneous reading over 1500 ppm shall not be exceeded.

TABLE Z-2

Material	8-hour time weighted average	Acceptable ceiling concentration	Acceptable maximum peak above the acceptable ceiling concentration for an 8-hour shift	
			Concentration	Maximum duration
Benzene (Z37.4-1969)[1]	10 ppm	25 ppm	50 ppm	10 minutes
Beryllium and beryllium compounds (Z37.29-1970)	2μg/M³	5μg/M³	25μg/M³	30 minutes
Cadmium dust (Z37.5-1970)[3]	0.2 mg/M³	0.6 mg/M³		
Cadmium fume (Z37.5-1970)[3]	0.1 mg/M³	0.3 mg/M³		
Carbon disulfide (Z37.3-1968)	20 ppm	30 ppm	100 ppm	30 minutes
Carbon tetrachloride (Z37.17-1967)	10 ppm	25 ppm	200 ppm	5 minutes in any 4 hours
Chromic acid and chromates (Z37.7-1971)	1 mg/10M³			
Ethylene dibromide (Z37.31-1970)	20 ppm	30 ppm	50 ppm	5 minutes
Ethylene dichloride (Z37.21-1969)	50 ppm	100 ppm	200 ppm	5 minutes in any 3 hours
Fluoride as dust (Z37.28-1969)	2.5 mg/M³			
Formaldehyde (Z37.16-1967)[2]	3 ppm	5 ppm	10 ppm	30 minutes
Hydrogen fluoride (Z37.28-1969)	3 ppm			
Hydrogen sulfide (Z37.2-1966)		20 ppm	50 ppm	10 minutes once only if no other measurable exposure occurs
Mercury (Z37.8-1971)		1 mg/10M³		
Methyl chloride (Z37.18-1969)	100 ppm	200 ppm	300 ppm	5 minutes in any 3 hours
Methylene chloride (Z37.3-1969)	500 ppm	1,000 ppm	2,000 ppm	5 minutes in any 2 hours
Organo (alkyl) mercury (Z37.30-1969)	0.01 mg/M³	0.04 mg/M³		
Styrene (Z37.15-1969)	100 ppm	200 ppm	600 ppm	5 minutes in any 3 hours
Tetrachloroethylene (Z37.22-1967)	100 ppm	200 ppm	300 ppm	5 minutes in any 3 hours
Toluene (Z37.12-1967)	200 ppm	300 ppm	500 ppm	10 minutes
Trichloroethylene (Z37.19-1967)	100 ppm	200 ppm	300 ppm	5 minutes in any 2 hours

[1]This standard applies to the industry segments exempt from the 1 ppm 8-hour TWA and 5 ppm STEL of the benzene standard at 1910.1028. This standard also applies to any industry for which 1910.1028 is stayed or otherwise not in effect.

[2]This standard applies to any industry for which 1910.1048 is stayed or otherwise not in effect.

[3]This standard applies to any operations or sectors for which 1910.1027 is stayed or otherwise not in effect.

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TABLE Z-3–Mineral Dusts

Substance	Mppcf[e]	mg/m³
SILICA:		
CRYSTALLINE		
QUARTZ (RESPIRABLE)	250[f]	10 MG/m³[m]
QUARTZ (TOTAL DUST)	%SiO_2 + 5	%SiO_2 + 2 30 mg/m³
CRISTOBALITE: Use ½ the value calculated from the count or mass formulas for quartz		
TRIDYMITE: Use ½ the value calculated from the formulae for quartz		
AMORPHOUS, including natural diatomaceous earth	20	80 mg/m³
		%SiO_2
SILICATES (less than 1% crystalline silica):		
Mica	20	.....
Soapstone	20	.....
Talc (not containing asbestos)	20[n]	
Talc (containing asbestos). Use asbestos limit	50	.....
Tremolite (see 29 CFR 1910.1101)		
Portland cement		
GRAPHITE (NATURAL)	15	.....
COAL DUST (respirable fraction less than 5% SiO_2)		2.4 mg/m³ or
For more than 5% SiO_2		10 mg/m³
		%SiO_2 + 2
INERT OR NUISANCE DUST:[g]		
Respirable fraction	15	5 mg/m³
Total dust	50	15 mg/m³

Note: Conversion Fractors — mppcf × 35.3 = million particles per cubic meter = particles per c.c.

[e]Millions of particles per cubic foot of air, based on impinger samples counted by light-field techniques.

[f]The percentage of crystalline silica in the formula is the amount determined from airborne samples, except in those instances in which other methods have been shown to be applicable.

[g]All inert or nuisance dusts, whether mineral, inorganic, or organic, not listed specifically by substance name, are covered by the Particulates Not Otherwise Regulated (PNOR) limit in Table Z-1-A.

[m]Both concentration and percent quartz for the application of this limit are to be determined from the fraction passing a size-selector with the following characteristics:

Aerodynamic diameter (unit density sphere)	Percent passing selector
2	90
2.5	75
3.5	50
5.0	25
10	0

[n]Containing less than 1% quartz; if 1% quartz, use quartz limit.

The measurements under this note refer to the use of an AEC (now NRC) instrument. The respirable fraction of coal dust is determined with an MRE; the figure corresponding to that of 2.4 mg/m³ in the table for coal dust is 4.5 mg/m³.

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• Re: 1910.1003 through 1910.1016

The following definitions apply to the handling of the substances listed below which are referred to in the definitions as "*agent involved.*"

.1003 4-Nitrobiphenyl.
.1004 alpha-Naphthylamine.
.1005 4,4'-Methylene bis(2-chloroaniline).
.1006 Methyl chloromethyl ether
.1007 3,3'-Dichlorobenzine (and its salts).
.1008 bis-Chloromethyl ether.
.1009 beta-Naphthylamine.
.1010 Benzidine.
.1011 4-Aminodiphenyl.
.1012 Ethyleneimine.
.1013 beta-Propiolactone.
.1014 2-Acetylaminofluorene.
.1015 4-Dimethylaminoazobenzene.
.1016 N-Nitrosodimethylamine.

(1)"Absolute filter" is one capable of retaining 99.97 percent of mono disperse aerosol of 0.3μm particles.

(2) "Authorized employee" means an employee whose duties require him to be in the regulated area and who has been specifically assigned by the employer.

(3) "Clean change room" means a room where employees put on clean clothing and/or protective equipment in an environment free of "*agent involved.*" The clean change room shall be contiguous to and have an entry from a shower room, when the shower room facilities are otherwise required in this section.

(4) "Closed system" means an operation involving "*agent involved*" where containment prevents the release of "*agent involved*" into regulated areas, nonregulated areas, or the external environment.

(5) "Decontamination" means the inactivation of "*agent involved*" or its safe disposal.

(6) "Director" means the Director, National Institute for Occupational Safety and Health, or any person directed by him or the Secretary of Health, Education, and Welfare to act for the Director.

(7) "Disposal" means the safe removal of "*agent involved*" from the work environment.

(8) "Emergency" means an unforeseen circumstance or set of circumstances resulting in the release of "*agent involved*" which may result in exposure to or contact with "*agent involved.*"

(9) "External environment" means any environment external to regulated and nonregulated areas.

(10) "Isolated system" means a fully enclosed structure other than the vessel of containment of "*agent involved,*" which is impervious to the passage of "*agent involved,*" and which would prevent the entry of "*agent involved*" into regulated areas, nonregulated areas, or the external environment, should leakage or spillage from the vessel of containment occur.

(11) "Laboratory type hood" is a device enclosed on three sides and the top and bottom, designed and maintained so as to draw air inward at an average linear face velocity of 150 feet per minute with a minimum of 125 feet per minute; designed, constructed, and maintained in such a way that an operation involving "*agent involved*" within the hood does not require the insertion of any portion of any employee's body other than his hands and arms.

(12) "Nonregulated area" means any area under the control of the employer where entry and exit is neither restricted nor controlled.

(13) "Open-vessel system" means an operation involving "*agent involved*" in an open vessel, which is not in an isolated system, a laboratory type hood, nor in any other system affording equivalent protection against the entry of "*agent involved*" into regulated areas, nonregulated areas, or the external environment.

(14) "Protective clothing" means clothing designed to protect an employee against contact with or exposure to "*agent involved.*"

(15) "Regulated area" means an area where entry and exit is restricted and controlled.

Appendix to §1910.1001 – OSHA Reference Method – Mandatory

This mandatory appendix specifies the procedure for analyzing air samples for asbestos and specifies quality control procedures that must be implemented by laboratories performing the analysis. The sampling and analytical methods described below represent the elements of the available monitoring methods (such as the NIOSH 7400 method) which OSHA considers to be essential to achieve adequate employee exposure monitoring while allowing employers to use methods that are already established within their organizations. All employers who are required to conduct air monitoring under paragraph (f) of the standard are required to utilize analytical laboratories that use this procedure, or an equivalent method, for collecting and analyzing samples.

Sampling and Analytical Procedure

1. The sampling medium for air samples shall be mixed cellulose ester filter membranes. These shall be designated by the manufacturer as suitable for asbestos counting. See below for rejection of blanks.
2. The preferred collection device shall be the 25-mm diameter cassette with an open-faced 50-mm extension cowl. The 37-mm cassette may be used if necessary but only if written justification accompanies the sample results in the employee's exposure monitoring record.
3. An air flow rate between 0.5 liter/min and 2.5 liters/min shall be selected for the 25-mm cassette. If the 37-mm cassette is used, an air flow rate between 1 liter/min and 2.5 liters/min shall be selected.
4. Where possible, a sufficient air volume for each air sample shall be collected to yield between 100 and 1,300 fibers per square millimeter on the membrane filter. If a filter darkens in appearance or if loose dust is seen on the filter, a second sample shall be started.
5. Ship the samples in a rigid container with sufficient packing material to prevent dislodging the collected fibers. Packing material that has a high electrostatic charge on its surface (e.g., expanded polystyrene) cannot be used because such material can cause loss of fibers to the sides of the cassette.
6. Calibrate each personal sampling pump before and after use with a representative filter cassette installed between the pump and the calibration devices.
7. Personal samples shall be taken in the "breathing zone" of the employee (i.e., attached to or near the collar or lapel near the worker's face).
8. Fiber counts shall be made by positive phase contrast using a microscope with an 8 to 10 X eyepiece and a 40 to 45 X objective for a total magnification of approximately 400 X and a numerical aperture of 0.65 to 0.75. The microscope shall also be fitted with a green or blue filter.
9. The microscope shall be fitted with a Walton-Beckett eyepiece graticule calibrated for a field diameter of 100 micrometers (± 2 micrometers).
10. The phase-shift detection limit of the microscope shall be about 3° measured using the HSE phase shift test slide as outlined below.
    a. Place the test slide on the microscope stage and center it under the phase objective.
    b. Bring the blocks of grooved lines into focus .

Note.– The slide consists of seven sets of grooved lines (ca. 20 grooves to each block) in descending order of visibility from sets 1 to 7, 7 being the least visible. The requirements for asbestos counting are that the microscope optics must resolve the grooved lines in set 3 completely, although they may appear somewhat faint, and that the grooved lines in sets 6 and 7 must be invisible. Sets 4 and 5 must be at least partially visible but may vary slightly in visibility between microscopes. A microscope that fails to meet these requirements has either too low or too high a resolution to be used for asbestos counting.

    c. If the image deteriorates, clean and adjust the microscope optics. If the problem persists, consult the microscope manufacturer.
11. Each set of samples taken will include 10% blanks or a minimum of 2 blanks. The blank results shall be averaged and subtracted from the analytical results before reporting. Any samples represented by a blank having a fiber count in excess of 7 fibers/100 fields shall be rejected.
12. The sample shall be mounted by the acetone/triacetin method or a method with an equivalent index of refraction and similar clarity.
13. Observe the following counting rules:
    a. Count only fibers equal to or longer than 5 micrometers. Measure the length of curved fibers along the curve.
    b. Count all particles as asbestos that have a length-to-width ratio (aspect ratio) of 3:1 or greater.

c. Fibers lying entirely within the boundary of the Walton-Beckett graticule field shall receive a count of 1. Fibers crossing the boundary once, having one end within the circle, shall receive the count of one half (½). Do not count any fiber that crosses the graticule boundary more than once. Reject and do not count any other fibers even though they may be visible outside the graticule area.

d. Count bundles of fibers as one fiber unless individual fibers can be identified by observing both ends of an individual fiber.

e. Count enough graticule fields to yield 100 fibers. Count a minimum of 20 fields; stop counting at 100 fields regardless of fiber count.

14. Blind recounts shall be conducted at the rate of 10%

Quality Control Procedures

1. Intralaboratory program. Each laboratory and/or each company with more than one microscopist counting slides shall establish a statistically designed quality assurance program involving blind recounts and comparisons between microscopists to monitor the variability of counting by each microscopist and between microscopists. In a company with more than one laboratory, the program shall include all laboratories and shall also evaluate the laboratory-to-laboratory variability.

2. Interlaboratory program. Each laboratory analyzing asbestos samples for compliance determination shall implement an interlaboratory quality assurance program that as a minimum includes participation of at least two other independent laboratories. Each laboratory shall participate in round robin testing at least once every six months with at least all the other laboratories in its interlaboratory quality assurance group. Each laboratory shall submit slides typical of its own workload for use in this program. The round robin shall be designed and results analyzed using appropriate statistical methodology.

3. All individuals performing asbestos analysis must have taken the NIOSH course for sampling and evaluating airborne asbestos dust or an equivalent course.

4. When the use of different microscopes contributes to differences between counters and laboratories, the effect of the different microscope shall be evaluated and the microscope shall be replaced, as necessary.

5. Current results of these quality assurance programs shall be posted in each laboratory to keep the microscopists informed.

Appendix B to §1910.1001 – Detailed Procedure for Asbestos Sampling and Analysis – Non-Mandatory

This appendix contains a detailed procedure for sampling and analysis and includes those critical elements specified in Appendix A. Employers are not required to use this procedure, but they are required to use Appendix A. The purpose of Appendix B is to provide a detailed step-by-step sampling and analysis procedure that conforms to the elements specified in Appendix A. Since this procedure may also standardize the analysis and reduce variability, OSHA encourages employers to use this appendix.

Asbestos Sampling and Analysis Method

Technique: Microscopy, Phase Contrast

Analyte: Fibers (manual count)

Sample Preparation: Acetone/triacetin method

Calibration: Phase-shift detection limit about 3°

Range: 100 to 1300 fibers/mm^2 filter area

Estimated limit of detection: 7 fibers/mm^2 filter area

Sampler: Filter (0.8–1.2 um mixed cellulose ester membrane, 25-mm diameter)

Flow rate: 0.5 l/min to 2.5 l/min (25-mm cassette) 1.0 l/min to 2.5 l/min (37-mm cassette)

Sample volume: Adjust to obtain 100 to 1300 fibers/mm^2

Shipment: Routine

Sample stability: Indefinite

Blanks: 10% of samples (minimum 2)

Standard analytical error: 0.25.

Applicability: The working range is 0.02 f/cc (1920–L air sample) to 1.25 f/cc (400-L air sample). The method gives an index of airborne asbestos fibers but may be used for other materials such as fibrous glass by inserting suitable parameters into the counting rules. The method does not differentiate between asbestos other fibers. Asbestos fibers less than ca. 0. 25 um diameter will not be detected by this method.

Interferences: Any other airborne fiber may interfere since all particles meeting the counting criteria are counted. Chainlike particles may appear fibrous. High levels of non-fibrous dust particles may obscure fibers in the field of view and raise the detection limit.

Reagents: 1. Acetone. 2. Triacetin (glycerol triacetate), reagent grade

Special precautions: Acetone is an extremely flammable liquid and precautions must be taken not to ignite it. Heating of acetone must be done in a ventilated laboratory fume hood using a flameless, spark-free heat source.

Equipment:

1. Collection device: 25-mm cassette with 50-mm extension cowl with cellulose ester filter, 0.8 to 1.2 mm pore size and backup pad.

Note.– Analyze representative filters for fiber back-ground before use and discard the filter lot if more than 5 fibers/100 fields are found.

2. Personal sampling pump, greater than or equal to 0.5 l/min. with flexible connecting tubing.
3. Microscope, phase contrast, with green or blue filter, 8 to 10X eyepiece, and 40 to 45X phase objective (total magnification ca 400X; numerical aperture = 0.65 to 0.75.
4. Slides, glass, single-frosted, pre-cleaned, 25 x 75 mm.
5. Cover slips, 25 x 24 mm, no. 1½ unless otherwise specified by microscope manufacturer.
6. Knife, No. I surgical steel, curved blade.
7. Tweezers.
8. Flask, Guth-type, insulated neck, 250 to 500 mL (with single-holed rubber stopper and elbow-jointed glass tubing, 16 to 22 cm long).
9. Hotplate, spark-free, stirring type; heating mantle; or infrared lamp and magnetic stirrer.
10. Syringe, hypodermic, with 22-gauge needle.
11. Graticule, Walton-Beckett type with 100 um diameter circular field at the specimen plane (area = 0.00785 mm^2). (Type G-22).

Note.– the graticule is custom-made for each microscope

12. HSE/NPL phase contrast test slide, Mark II.
13. Telescope, ocular phase-ring centering.
14. Stage micrometer (0.01 mm divisions).

Sampling

1. Calibrate each personal sampling pump with a representative sampler in line.
2. Fasten the sampler to the worker's lapel as close as possible to the worker's mouth. Remove the top cover from the end of the cowl extension (open face) and orient face down. Wrap the joint between the extender and the monitor's body with shrink tape to prevent air leaks.
3. Submit at least two blanks (or 10% of the total samples, whichever is greater) for each set of samples. Remove the caps trom the field blank cassettes and store the caps and cassettes in a clean area (bag or box) during the sampling period. Replace the caps in the cassettes when sampling is completed.
4. Sample at 0.5 L/min or greater. Do not exceed 1 mg total dust loading on the filter. Adjust sampling flow rate, Q (L/min), and time to produce to fiber density, E (fibers/mm^2), of 100 to 1300 fibers/ m^2 [3.85 x 10^4 to 5 x 10^5 fibers per 25-mm filter with effective collection area (A_c = 385 mm^2) for optimum counting precision (see step 21 below). Calculate the minimum sampling time, $t_{minimum}$ (min) at the action level

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(one-half of the current standard), L (f/cc) of the fibrous aerosol being sampled:

$$t_{min} = \frac{[Ac][E]}{[Q][L]10^3}$$

5. Remove the field monitor at the end of sampling replace the plastic top cover and small end caps, and store the monitor.

6. Ship the samples in a rigid container with sufficient packing material to prevent jostling or damage.

Note.— Do not use polystyrene foam in the shipping container because of electrostatic forces which may cause fiber loss from the sampler filter.

Sample Preparation

Note.— The object is to produce samples with a smooth (non-grainy) background in a medium with a refractive index equal to or less than 1.46. The method below collapses the filter for easier focusing and produces permanent mounts which are useful for quality control and interlaboratory comparison. Other mounting techniques meeting the above criteria may also be used e g., the nonpermanent field mounting technique used in P & CAM 239.

7. Ensure that the glass slides and cover slips are free of dust and fibers.

8. Place 40 to 60 ml of acetone into a Gu type flask. Stopper the flask with a single-hole rubber stopper through which a glass tube extends 5 to 8 cm into the flask. The portion of the glass tube that exits the top the stopper (8 to 10cm) is bent downward an elbow that makes an angle of 20 to 30° with the horizontal.

9. Place the flask in a stirring hotplate or wrap in a heating mantle. Heat the acetone gradually to its boiling temperature (ca. 58°C).

Caution: The acetone vapor must be generated in a ventilated fume hood away from all open flames and spark sources. Alternate heating methods can be used, providing no open flame or sparks are present.

10. Mount either the whole sample filter or a wedge cut from the sample filter on a clean glass slide.

    a. Cut wedges of ca. 25% of the filter area with a curved-blade steel surgical knife using a rocking motion to prevent tearing.

    b. Place the filter or wedge, dust side up the slide. Static electricity will usually keep the filter on the slide until it is cleared.

    c. Hold the glass slide supporting the filter approximately 1 to 2 cm from the glass tube port where the acetone vapor is escaping from the heated flask. The acetone vapor stream should cause a condensation spot on the glass slide ca. 2 to 3 cm in diameter. Move the glass slide gently the vapor stream. The filter should clear in 2 to 5 sec. If the filter curls, distorts, or is otherwise rendered unusable. the vapor stream is probably not strong enough. Periodically wipe the outlet port with tissue to prevent liquid acetone from dripping onto the filter.

    d. Using the hypodermic syringe with a 22-gauge needle, place 1 to 2 drops of triacetin on the filter. Gently lower a clean 25-mm square cover slip down onto the filter at a slight angle to reduce the possibility of forming bubbles. If too many bubbles form or the amount of triacetin is insufficient, the cover slip may become detached within a few hours.

    e. Glue the edges of the cover slip to the glass slide using a lacquer or nail polish.

Note.— If clearing is slow, the slide preparation may be heated on a hotplate (surface temperature 50°C) for 15 min to hasten clearing. Counting may proceed immediately after clearing and mounting are completed.

Calibration and Quality Control

11. Calibration of the Walton-Beckett graticule. The diameter, d_c(mm), of the circular counting area and the disc diameter must be specified when ordering the graticule.

    a. Insert any available graticule into the eyepiece and focus so that the graticule lines are sharp and clear.

    b. Set the appropriate interpupillary distance and, if applicable, reset the binocular head adjustment so that the magnification remains constant.

    c. Install the 40 to 45 X phase objective.

    d. Place a stage micrometer on the microscope object stage and focus the microscope on the graduate lines.

    e. Measure the magnified grid length, L_o(mm), using the stage micrometer.

    f. Remove the graticule from the microscope and measure its actual grid length, L_a(mm). This can best be accomplished by using a stage fitted with verniers.

g. Calculate the circle diameter, d_c(mm), for the Walton-Beckett graticule:

$$d_c = \frac{L_a \times D}{L_o}$$

Example — If L_o = 108 um, L_a = 2.93 mm and D = 100 um, then d_c = 2.71 mm.

h. Check the field diameter, D(acceptable range 100 mm ± 2 mm) with a stage micrometer upon receipt of the graticule from the manufacturer. Determine field area (mm^2).

12. Microscope adjustments. Follow the manufacturer's instructions and also the following:

a. Adjust the light source for even illumination across the field of view at the condenser iris.

Note.— Kohler illumination is preferred, where available.

b. Focus on the particulate material to be examined.

c. Make sure that the field iris is in focus, centered on the sample, and open only enough to fully illuminate the field of view.

d. Use the telescope ocular supplied by the manufacturer to ensure that the phase rings (annular diaphragm and phase-shifting elements) are concentric.

13. Check the phase-shift detection limit of the microscope periodically.

a. Remove the HSE/NPL phase-contrast test slide from its shipping container and center it under the phase objective.

b. Bring the blocks of grooved lines into focus.

Note.— The slide consists of 7 sets of grooves (ca. 20 grooves to each block) in descending order of visibility from sets 1 to 7. The requirements for counting are that the microscope optics must resolve the grooved lines in set 3 completely, although they may appear somewhat faint, and that the grooved lines in sets 6 to 7 must be invisible. Sets 4 and 5 must be at least partially visible but may vary slightly in visibility between microscopes. A microscope which fails to meet these requirements has either too low or too high a resolution to be used for asbestos counting.

c. If the image quality deterioriates, clean the microscope optics and, if the problem persists, consult the microscope manufacturer.

14. Quality control of fiber counts.

a. Prepare and count field blanks along with the field samples. Report the counts on each blank. Calculate the mean of the field blank counts and subtract this value from each sample count before reporting the results.

Note 1.— The identity of the blank filters should be unknown to the counter until all counts have been completed.

Note 2.— If a field blank yields fiber counts greater than 7 fibers/100 field, report possible contamination of the samples.

b. Perform blind recounts by the same counter on 10% of filters counted (slides relabeled by a person other than the counter)

15. Use the following test to determine whether a pair of counts on the same filter should be rejected because of possible bias. This statistic estimates the counting repeatability at the 95% confidence level. Discard the sample if the difference between the two counts exceeds 2.77(F) s_r, where F = average of the two fiber counts and s_r = relative standard deviation, which should be derived by each laboratory based on historical in-house data.

Note.— If a pair of counts is rejected as a result of this test, recount the remaining samples in the set and test the new counts against the first counts. Discard all rejected paired counts.

16. Enroll each new counter in a training course that compares performance of counters on a variety of samples using this procedure.

Note.— To ensure good reproducibility, all laboratories engaged in asbestos counting are required to participate in the Proficiency Analytical Testing (PAT) Program and should routinely participate with other asbestos fiber counting laboratories in the exchange of field samples to compare performance of counters.

Measurement

17. Place the slide on the mechanical stage of the calibrated microscope with the center of the filter under the objective lens. Focus the microscope on the plane of the filter.

18. Regularly check phase-rind alignment and Kohler illumination.

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19. The following are the counting rules:

   a. Count only fibers longer than 5 um. Measure the length of curved fibers along the curve.

   b. Count only fibers with a length-to-width ratio equal to or greater than 3:1.

   c. For fibers that cross the boundary of the graticule field, do the following:

      1. Count any fiber longer than 5 um that lies entirely within the graticule area.

      2. Count as ½ fiber any fiber with only one end lying within the graticule area.

      3. Do not count any fiber that crosses the graticule boundary more than once.

      4. Reject and do not count all other fibers.

   d. Count bundles of fibers as one fiber unless individual fibers can be identified by observing both ends of a fiber.

   e. Count enough graticule fields to yield 100 fibers. Count a minimum of 20 fields. Stop at 100 fields regardless of fiber count.

20. Start counting from one end of the filter and progress along a radial line to the other end, shift either up or down on the filter, and continue in the reverse direction. Select fields randomly by looking away from the eyepiece briefly while advancing the mechanical stage. When an agglomerate covers ca. ⅙ or more of the field of view, reject the field and select another. Do not report rejected fields in the number of total fields counted.

Note.— When counting a field, continuously scan a range of focal planes by moving the fine focus knob to detect very fine fibers which have become embedded in the filter. The small-diameter fibers will be very faint but are an important contribution to the total count.

Calculations

21. Calculate and report fiber density on the filter, E (fibers/mm^2); by dividing the total fiber count, F; minus the mean field blank count, B, by the number of fields, n; and the field area, A_f (0.00785 mm^2 for a properly calibrated Walton-Beckett graticule):

$$E = \frac{F - B,}{[n][A_r]} \text{ fibers/mm}^2$$

22. Calculate the concentration, C (f/cc), of fibers in the air volume sampled, V(L), using the effective collection area of the filter, A_c (385 mm^2 for a 25-mm filter):

$$C = \frac{[E][Ac]}{V[10^3]}$$

Note.— Periodically check and adjust the value of A_c, if necessary.

Appendix C to § 1910.1001—Qualitative and Quantitative Fit Testing Procedures—Mandatory

Qualitative Fit Test Protocols

I. Isoamyl Acetate Protocol.

A. Odor Threshold Screening

1. Three 1-liter glass jars with metal lids (e.g. Mason or Bell jars) are required.
2. Odor-free water (e.g. distilled or spring water) at approximately 25°C shall be used for the solutions.
3. The isoamyl acetate (IAA) (also known as isopentyl acetate) stock solution is prepared by adding 1 cc of pure IAA to 800 cc of odor-free water in a 1-liter jar and shaking for 30 seconds. This solution shall be prepared new at least weekly.
4. The screening test shall be conducted in a room separate from the room used for actual fit testing. The two rooms shall be well ventilated but shall not be connected to the same recirculating ventilation system.
5. The odor test solution is prepared in a second jar by placing 0.4 cc of the stock solution into 500 cc of odor-free water using a clean dropper or pipette. Shake for 30 seconds and allow to stand for two to three minutes so that the IAA concentration above the liquid may reach equilibrium. This solution may be used for only one day.
6. A test blank is prepared in a third jar by adding 500 cc of odor-free water.
7. The odor test and test blank jars shall be labelled 1 and 2 for jar identification. If the labels are put on the lids they can be periodically peeled, dried off and switched to maintain the integrity of the test.
8. The following instructions shall be typed on a card and placed on the table in front of the two test jars (i.e. 1 and 2): "The purpose of this test is to determine if you can smell banana oil at a low concentration. The two bottles in front of you contain water. One of these bottles also contains a small amount of banana oil. Be sure the covers are on tight, then shake each bottle for two seconds. Unscrew the lid of each bottle, one at a time, and sniff at the mouth of the bottle. Indicate to the test conductor which bottle contains banana oil."
9. The mixtures used in the IAA odor detection test shall be prepared in an area separate from where the test is performed, in order to prevent olfactory fatigue in the subject.
10. If the test subject is unable to correctly identify the jar containing the odor test solution, the IAA qualitative fit test may not be used.
11. If the test subject correctly identifies the jar containing the odor test solution, the test subject may proceed to respirator selection and fit testing.

B. Respirator Selection

1. The test subject shall be allowed to pick the most comfortable respirator from a selection including respirators of various sizes from different manufacturers. The selection shall include at least five sizes of elastomeric half facepieces, from at least two manufacturers.
2. The selection process shall be conducted in a room separate from the fit-test chamber to prevent oder fatigue. Prior to the selection process, the test subject shall be shown how to put on a respirator, how it should be positioned on the face, how to set strap tension and how to determine a "comfortable" respirator. A mirror shall be available to assist the subject in evaluating the fit and positioning of the respirator. This instruction may not constitute the subject's formal training on respirator use, as it is only a review.
3. The test subject should understand that the employee is being asked to select the respirator which provides the most comfortable fit. Each respirator represents a different size and shape and, if fit properly and used properly will provide adequate protection.
4. The test subject holds each facepiece up to the face and eliminates those which obviously do not give a comfortable fit. Normally, selection will begin with a half-mask and if a good fit cannot be found, the subject will be asked to test the full facepiece respirators. (A small percentage of users will not be able to wear any half-mask.)
5. The more comfortable facepieces are noted; the most comfortable mask is donned and *worn at least five minutes* to assess comfort. All donning and adjustments of the facepiece shall be performed by the test subject without assistance from the test conductor or other person. Assistance in assessing confort can be given by discussing the point in #6 below. If the test subject is not familiar with using a particular respirator, the test subject shall be directed to don the mask several times and to adjust the straps each time to become adept to setting proper tension on the straps.
6. Assessment of comfort shall include reviewing the following points with the test subject and allowing the test subject adequate time to determine the comfort of the respirator:
   - Positioning of mask on nose.
   - Room for eye protection.
   - Room to talk.
   - Positioning mask on face and cheeks.
7. The following criteria shall be used to help determine thequacy of the respirator fit:
   - Chin properly placed.
   - Strap tension.
   - Fit across nose bridge.
   - Distance from nose to chin.
   - Tendency to slip.
   - Self-observation in mirror.

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8. The test subject shall conduct the conventional negative and positive-pressure fit checks (e.g. see ANSI Z88.2-1980). Before conducting the negative and positive-pressure test the subject shall be told to "seat" the mask by rapidly moving the head from side-to-side and up and down, while taking a few deep breaths.

9. The test subject is now ready for fit testing.

10. After passing the fit test, the test subject shall be questioned again regarding the comfort of the repirator. If it has become uncomfortable, another model of respirator shall be tried.

11. The employee shall be given the opportunity to select a different facepiece and be retested if the chosen facepiece becomes increasingly uncomfortable at any time.

C. Fit Test

1. The fit test chamber shall be similar to clear 55 gal drum liner suspended inverted over a 2 foot diameter frame, so that the top of the chamber is about 6 inches above the test subject's head. The inside top center of the chamber shall have a small hook attached.

2. Each respirator used for the fitting and testing shall be equipped with organic vapor cartridges or offer protection against organic vapors. The cartridges or masks shall be changed at least weekly.

3. After selecting, donning, and properly adjusting a respirator, the test subject shall wear it to the fit testing room. This room shall be separate from the room used for odor threshold screening and rspirator selection and shall be well ventilated, as by an exhaust fan or lab hood, to prevent general room contamination.

4. A copy of the following test exercises and rainbow passage shall be taped to the inside of the test chamber:

Test Exercises

i. Breathe normally.

ii. Breathe deeply. Be certain breaths are *deep* and *regular*.

iii. Turn head all the way from one side to the other. Inhale on each side. Be certain movement is complete. Do not bump the respirator against the shoulders.

iv. Nod head up-and-down. Inhale when head is in the full up position (looking toward ceiling). Be certain motions are complete and made about every second. Do not bump the respirator on the chest.

v. Talking. Talk aloud and slowly for several minutes. The following paragraph is called the Rainbow Passage. Reading it will results in a wide range of facial movements, and thus be useful to satisfy this requirement. Alternative passages which serve the same purpose may also be used.

vi. Jogging in place.

vii. Breathe normally.

Rainbow Passage

When the sunlight strikes raindrops in the air, they act like a prism and form a rainbow. The rainbow is a division of white light into many beautiful colors. These take the shape of a long round arch, with its path high above, and its two ends apparently beyond the horizon. There is, according to legend, a boiling pot of gold at one end. People look but no one ever finds it. When a man looks for something beyond reach, his friends say he is looking for the pot of gold at the end of the rainbow.

5. Each test subject shall wear the respirator for at least 10 minutes before starting the fit test.

6. Upon entering the test chamber, the test subject shall be given a 6 inch by 5 inch piece of paper towel or other porous absorbent single ply material, folded in half and wetted with three-quarters of one cc of pure IAA. The test subject shall hang the wet towel on the hook at the top of the chamber.

7. Allow two minutes for the IAA test concentration to be reached before starting the fit-test exercises. This would be an appropriate time to talk with the test subject, to explain the fit test, the importance of cooperation, the purpose for the head exercises, or to demonstrate some of the exercises.

8. Each exercise described in #4 above shall be performed for at least one minute.

9. If at any time during the test, the subject detects the banana-like odor of IAA, the test has failed. The subject shall quickly exit from the test chamber and leave the test area to avoid olfactory fatigue.

10. If the test is failed, the subject shall return to the selection room and remove the respirator, repeat the odor sensitivity test, select and put on another respirator, return to the test chamber, and again begin the procedure described in the c(4) through c(8) above. The process continues until a respirator that fits well has been found. Should the odor sensitivity test be failed, the subject shall wait about 5 minutes before retesting. Odor sensitivity will usually have returned by this time.

11. If a person cannot pass the fit test described above wearing a half-mask respirator from the available selection, full facepiece models must be used.

12. When a respirator is found that passes the test, the subject breaks the faceseal and takes a breath before exiting the chamber. This is to assure that the reason the test subject is not smelling the IAA is the good fit of the respirator facepiece seal and not olfactory fatigue.

13. When the test subject leaves the chamber, the subject shall remove the saturated towel and return it to the person conducting the test. To keep the area from becoming contaminated, the used towels shall be kept in a self-sealing bag so there is no significant IAA concentration buildup in the test chamber during subsequent tests.

14. At least two facepieces shall be selected for the IAA test protocol. The test subject shall be given the opportunity to wear them for one week to choose the one which is more comfortable to wear.
15. Persons who have successfully passed this fit test with a half-mask respirator may be assigned the use of the test respirator in atmospheres with up to 10 times the PEL of airborne asbestos. In atmospheres greater than 10 times, and less than 100 times the PEL (up to 100 ppm), the subject must pass the IAA test using a full face negative pressure respirator. (The concentration of the IAA inside the test chamber must be increased by ten times for QLFT of the full facepiece.)
16. The test shall not be conducted if there is any hair growth between the skin and the facepiece sealing surface.
17. If hair growth or apparel interfere with a satisfactory fit, then they shall be altered or removed so as to eliminate interference and allow a satisfactory fit. If a satisfactory fit is still not attained, the test subject must use a positive-pressure respirator such as powered air-purifying respirators, supplied air respirator, or self-contained breathing apparatus.
18. If a test subject exhibits difficulty in breathing during the tests, she or he shall be referred to a physicain trained in respirator disease or pulmonary medicine to determine whether the test subject can wear a respirator while performing her or his duties.
19. Qualitative fit testing shall be repeated at least every six months.
20. In addition, because the sealing of the respirator may be affected, qualitative fit testing shall be repeated immediately when the test subject has a:
    (1) Weight change of 20 pounds or more,
    (2) Significant facial scarring in the area of the facepiece seal,
    (3) Significant dental changes; i.e., multiple extractions without prosthesis, or acquiring dentures,
    (4) Recontrutive or cosmetic surgery, or
    (5) Any other condition that may interfere with facepiece sealing.

D. Recordkeeping

A summary of all test results shall be maintained in each office for three years. The summary shall include:

(1) Name of test subject.
(2) Date of testing.
(3) Name of the test conductor.
(4) Respirators selected (indicate manufacturer, model, size and approval number).
(5) Testing agent.

II. Saccharin Solution Aerosol Protocol

A. Respirator Selection

Respirators shall be selected as described in section IB (respirator selection) above, except that each respirator shall be equipped with a particulate filter.

B. Taste Threshold Screening

1. An enclosure about head and shoulders shall be used for threshold screening (to determine if the individual can taste saccharin) and for fit testing. The enclosure shall be approximately 12 inches in diameter by 14 inches tall with at least the front clear to allow free movement of the head when a respirator is worn.
2. The test enclosure shall have a three-quarter inch hole in front of the test subject's nose and mouth area to accommodate the nebulizer nozzle.
3. The entire screening and testing procedure shall be explained to the test subject prior to conducting the screening test.
4. During the threshold screening test, the test subject shall don the test enclosure and breathe with open mouth with tongue extended.
5. Using a DeVilbiss Model 40 Inhalation Medication Nebulizer or equivalent, the test conductor shall spray the threshold check solution into the enclosure. This nebulizer shall be clearly marked to distinguish it from the fit test solution nebulizer.
6. The threshold check solution consists of 0.83 grams of sodium saccharin, USP in water. It can be prepared by putting 1 cc of the test solution (see C7 below) in 100 cc of water.
7. To produce the aerosol, nebulizer bulb is firmly squeezed so that it collapses completely, then is released and allowed to fully expand.
8. Ten squeezes of the nebulizer bulb are repeated rapidly and then the test subject is asked whether the saccharin can be tasted.
9. If the first response is negative, ten more squeezes of the nebulizer bulb are repeated rapidly and the test subject is again asked whether the saccharin can be tasted.
10. If the second response is negative ten more squeezes are repeated rapidly and the test subject is again asked whether the saccharin can be tasted.
11. The test conductor will take note of the number of squeezes required to elicit a taste response.
12. If the saccharin is not tasted after 30 squeezes (Step 10), the saccharin fit test cannot be performed on the test subject.
13. If a taste response is elicited, the test subject shall be asked to take note of the taste for reference in the fit test.

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14. Correct use of the nebulizer means that approximately 1 cc of liquid is used at a time in the nebulizer body.

15. The nebulizer shall be thoroughly rinsed in water, shaken dry, and refilled at least every four hours.

C. Fit Test

1. The test subject shall don and adjust the respirator without assistance from any person.

2. The fit test uses the same enclosure described in IIB above.

3. Each test subject shall wear the respirator for at least 10 minutes before starting the fit test.

4. The test subject shall don the enclosure while wearing the respirator selected in section 1B above. This respirator shall be properly adjusted and equipped with a particulate filter.

5. The test subject may not eat, drink (except plain water), or chew gum for 15 minutes before the test.

6. A second DeVilbiss Model 40 Inhalation Medication Nebulizer is used to spray the fit test solution into the enclosure. This nebulizer shall be clearly marked to distinguish it from the screening test solution nebulizer.

7. The fit test solution is prepared by adding 83 grams of so saccharin to 100 cc of warm water.

8. As before, the test subject shall breathe with mouth open and tongue extended.

9. The nebulizer is inserted into the hole in the front of the enclosure and the fit test solution is sprayed into the enclosure using the same technique as for the taste threshold screening and the same number of squeezes required to elicit a taste response in the screening. (See B8 through B10).

10. After generation of the aerosol read the following instructions to the test subject. The test subject shall perform the exercises for one minute each.

    i. Breathe normally.

    ii. Breathe deeply. Be certain breaths are *deep and regular.*

    iv. Nod head up-and-down. Be certain motions are complete. Inhale when head is in the full up position (when looking toward the ceiling). Do not bump respirator on the chest.

    v. Talking. Talk loudly and slowly for several minutes. The following paragraph is called the Rainbow Passage. Reading it will result in a wide range of facial movements, and thus be useful to satisfy this requirement. Alternative passages which serve the same purpose may also be used.

    vi. Jogging in place.

    vii. Breathe normally.

Rainbow Passage

When the sunlight strikes raindrops in the air, they act like a prism and form a rainbow. The rainbow is a division of white light into many beautiful colors. These take the shape of a long round arch, with its path high above, and its two ends apparently beyond the horizon. There is, according to legend, a boiling pot of gold at one end. People look, but no one ever finds it. When a man looks for something beyond his reach, his friends say he is looking for the pot of gold at the end of the rainbow.

11. At the beginning of each exercise, the aerosol concentration shall be replenished using one-half the number of squeezes as intially described in C9.

12. The test subject shall indicate to the test conductor if at any time during the fit test the taste of saccharin is detected.

13. If the saccharin is detected the fit is deemed unsatisfactory and a different respirator shall be tried.

14. At least two facepieces shall be selected by the IAA test protocol. The test subject shall be given the opportunity to wear them for one week to choose the one which is more comfortable to wear.

15. Successful completion of the test protocol shall allow the use of the half mask tested respirator in contaminated atmospheres up to 19 times the PEL of asbestos. In other words this protocol may be used to assign protection factors no higher than 10.

16. The test shall not be conducted if there is any hair growth between the skin and the facepiece sealing surface.

17. If hair growth or apparel interfere with a satisfactory fit, then they shall be altered or removed so as to eliminate interference and allow a satisfactory fit. If a satisfactory fit is still not attained, the test subject must use a positive-pressure respirator such as powered air-purifying respirators, supplied air respirator, or self-contained breathing apparatus.

18. If a test subject exhibits difficulty in breathing during the tests, she or he shall be referred to a physician trained in respiratory diseases or pulmonary medicine to determine whether the test subject can wear a respirator while performing her or his duties.

19. Qualitative fit testing shall be repeated at least every six months.

20. In addition, because the sealing of the respirator may be affected, qualitative fit testing shall be repeated immediately when the test subject has a:

    (1) Weight change of 20 pounds or more,

    (2) Significant facial scarring in the area of the facepiece seal,

    (3) Significant dental changes; i.e.; multiple extractions without prosthesis, or acquiring dentures,

(4) Reconstructive or cosmetic surgery, or

(5) Any other condition that may interfere with facepiece sealing

D. Recordkeeping

A summary of all test results shall be maintained in each office for three years. The summary shall include:

(1) Name of test subject.

(2) Date of testing.

(3) Name of test conductor.

(4) Respirators selected (indicate manufacturer, model, size and approval number).

(5) Testing agent.

III. Irritant Fume Protocol

A. Respirator selection

Respirators shall be selcted as described in section IB above, except that each respirator shall equipped with a combination of high-efficiency and acid-gas cartridges.

B. Fit test

1. The test subject shall be allowed to smell a weak concentration of the irritant smoke to familiarize the subject with the characteristic odor.
2. The test subject shall properly don the respirator selected as above, and wear it for at least 10 minutes before starting the fit test.
3. The test conductor shall review this protocol with the test subject before testing.
4. The test subject shall perform the conventional positive pressure and negative pressure fit checks (see ANSI Z88.2 1980) Failure of either check shall be cause to select an alternative respirator.
5. Break both ends of a ventilation smoke tube containing stannic oxychloride, such as the MSA part #5645, or equivalent. Attach a short length of tubing to one end of the smoke tube. Attach the other end of the smoke tube to a low pressure air pump set to deliver 200 milliliters per minute.
6. Advise the test subject that the smoke can be irrating to the eyes and instruct the subject to keep the eyes closed while the test is performed.
7. The test conducter shall direct the stream of irritant smoke from the tube towards the faceseal area of the test subject. The person conducting the test shall begin with the tube at least 12 inches from the facepiece and gradually move to within one inch, moving around the whole perimeter of the mask.
8. The test subject shall be instructed to do the following exercises while the respirator is being challenged by the smoke. Each exercise shall be performed for one minute.

   i. Breathe normally.

   ii. Breathe deeply. Be certain breaths are *deep* and *regular*.

   iii. Turn head all the way from one side to the other. Be certain movement is complete. Inhale on each side. Do not bump the respirator against the shoulders.

   iv. Nod head up-and-down. Be certain motions are complete and made every second. Inhale when head is in the full up position (looking toward ceiling). Do not bump the respirator against the chest.

   v. Talking. Talk aloud and slowly for several minutes. The following paragraph is called the Rainbow Passage. Reading it will result in a wide range of facial movements, and thus be useful to satisfy this requirement. Alternative passages which serve the same purpose may also be used.

   vi. Jogging in Place.

   vii. Breathe normally.

Rainbow Passage

When the sunlight strikes raindrops in the air, they act like a prism and form a rainbow. The rainbow is a division of white light into many beautiful colors. These take the shape of a long round arch, with its path high above, and its two ends apparently beyond the horizon. There is, according to legend, a boiling pot of gold at one end. People look, but no one ever finds it. When a man looks for something beyond his reach, his friends say he is looking for the pot of gold at the end of the rainbow.

9. The test subject shall indicate to the test conductor if the irritant smoke is detected. If smoke is detected, the test conductor shall stop the test. In this case, the tested respirator is rejected and another respirator shall be selected.
10. Each test subject passing the smoke test (i.e. without detecting the smoke) shall be given a sensitivity check of smoke from the same tube to determine if the test subject reacts to the smoke. Failure to evoke a response shall void the fit test.
11. Steps B4, B9, B10 of this fit test protocol shall be performed in a location with exhaust ventilation sufficient to prevent general contamination of the testing area by the test agents.
12. At least two facepieces shall be selected by the IAA test protocol. The test subject shall be given the opportunity to wear them for one week to choose the one which is more comfortable to wear.
13. Respirators successfully tested by the protocol may be used in contaminated atmospheres up to 10 times the PEL of asbestos.
14. The test shall not be conducted if there is any hair growth between the skin and the facepiece sealing surface.

15. If hair growth or apparel interfere with a satisfactory fit, then they shall be altered or removed so as to eliminate interference and allow a satisfactory fit. If a satisfactory fit is still not attained, the test subject must use a positive-pressure respirator such as powered air-purifing respirators respirators, supplied air respirator, or self-contained breathing apparatus.

16. If a test subject exhibits difficulty in breathing during the tests, she or he shall be referred to a physicain trained in respiratory diseases or pulmonary medicine to determine whether the test subject can wear a respirator while performing her or his duties.

17. Qualitative fit testing shall be repeated at least every six months.

18. In addition, because the sealing of the respirator may be affected, qualitative fit testing shall be repeated immediately when the test subject has a:

    (1) Weight change of 20 pounds or more.

    (2) Significant facial scarring in the area of the facepiece seal,

    (3) Significant dental changes; i.e., multiple extractions without prosthesis, or acquiring dentures,

    (4) Reconstructive or cosmetic surgery, or

    (5) Any other condition that may interfere with facepiece sealing.

C. Recordkeeping

A summary of all test results shall be maintained in each office for three years. The summary shall include:

(1) Name of test subject.

(2) Date of testing.

(3) Name of test conductor.

(4) Respirators selected (indicate manufacturer, model, size and approval number).

(5) Testing agent.

Quantitative Fit Test Procedures

1. *General.*

    a. The method applies to the negative-pressure nonpowered air-purifying respirators only.

    b. The employer shall assign one individual who shall assume the full responsibiltiy for implementing the respirator quantitative fit test program.

2. *Definition.*

    a. ''Quantitative Fit Test'' means the measurement of the effectiveness of a respirator seal in excluding the ambient atmosphere. The test is performed by dividing the measured concentration of challenge agent in a test chamber by the measured concentration of the challenge agent inside the respirator facepiece when the normal air purifying element has been replaced by an essentially perfect purifying element.

    b. ''Challenge Agent'' means the air contaminant introduced into a test chamber so that its concentration inside and outside the respirator may be compared.

    c. ''Test Subject'' means the person wearing the respirator for quantitative fit testing.

    d. ''Normal Standing Position'' means standing erect and straight with arms down along the side and looking straight ahead.

    e. ''Fit Factor'' means the ratio of challenge agent concentration outside with respect to the inside of a respirator inlet covering (facepiece or enclosure).

3. *Apparatus.*

    a. *Instrumentation.* Corn oil, sodium chloride or other appropriate aerosol generation, dilution, and measurement systems shall be used for quantitative fit test.

    b. *Test chamber.* The test chamber shall be large enough to permit all test subjects to freely perform all required exercises without distributing the challenge agent concentration or the measurement apparatus. The test chamber shall be equipped and constructed so that the challenge agent is effectively isolated from the ambient air yet uniform in concentration throughout the chamber.

    c. When testing air-purifying respirators, the normal filter or cartridge element shall be replaced with a high-efficiency particulate filter supplied by the same manufacturer.

    d. The sampling instrument shall be selected so that a strip chart record may be made of the test showing the rise and fall of challenge agent concentration with each inspiration and expiration at fit factors of at least 2,000.

    e. The combination of substitute air-purifying elements (if any), challenge agent, and challenge agent concentration in the test chamber shall be such that the test subject is not exposed in excess of PEL to the challenge agent at any time during the testing process.

    f. The sampling port on the test specimen respirator shall be placed and constructed so that there is no detectable leak around the port, a free air flow, is allowed into the sampling line at all times and so there is no interference with the fit or performance of the respirator.

    g. The test chamber and test set-up shall permit the person administering the test to observe one test subject inside the chamber during the test.

    h. The equipment generating the challenge atmosphere shall maintain the concentration of challenge agent constant within a 10% variation for the duration of the test.

    i. The time lag (interval between an event and its being recorded on the strip chart) of the instrumentation may not exceed two seconds.

j. The tubing for the test chamber atmosphere and for the respirator sampling port shall be the same diameter, length, and material. It shall be kept as short as possible. The smallest diameter tubing recommended by the manufacturer shall be used.

k. The exhaust flow from the test chamber shall pass through a high-efficiency filter before release to the room.

l. When sodium chloride aerosol is used, the relative humidity inside the test chamber shall not exceed 50 percent.

4. *Procedural Requirements.*

a. The fitting of half-mask respirators should be started with those having multiple sizes and a variety of interchangeable cartridges and canisters such as the MSA Comfo II-M, Norton M. Survivair M, A-O M, or Scott-M. Use either of the tests outlined below to assure that the facepiece is properly adjusted.

(1) *Positive pressure test.* With the exhaust port(s) blocked, the negative pressure of slight inhalation shoudl remain constant for several seconds.

(2) *Negative pressure test.* With the intake port(s) blocked, the negative pressure slight inhalation should remain constant for several seconds.

b. After a facepiece is adjusted, the test subject shall wear the facepiece for at least 5 minutes before conducting a qualitative test by using either of the methods described below and using the exercise regime described in 5.a., b., c., and e.

(1) *Isoamyl acetate test.* When using organic vapor cartridges, the test subject who can smell the odor should be unable to detect the odor of isoamyl acetate squirted into the air near the most vulnerable portions of the facepiece seal. In a location which is separated from the test area, the test subject shall be instructed to close her/his eyes during the test period. A combination cartridge or canister with organic vapor and high-efficiency filters shall be used when available for the particular mask being tested. The test subject shall be given an opportunity to smell the odor of isoamyl acetate before the test is conducted.

(2) *Irritant fume test.* When using high-efficiency filters, the test subject should be unable to detect the odor of irritant fume (stannic chloride or titanium tetrachloride ventilation smoke tubes) squirted into the air near the most vulnerable portions of the facepiece seal. The test subject shall be instructed to close her/his eyes during the test period.

c. The test subject may enter the quantitative testing chamber only if she or he has obtained a satisfactory fit as stated in 4.b., of this Appendix.

d. Before the subject enters the test chamber, a reasonably stable challenge agent concentration shall be measured in the test chamber.

e. Immediately after the subject enters the test chamber, the challenge agent concentration inside the respirator shall be measured to ensure that the peak penetration does not exceed 5% for a half-mask and 1% for a full facepiece.

f. A stable challenge agent concentration shall be obtained prior to the actual start of testing.

(1) Respirator restraining straps may not be overtightened for testing. The straps shall be adjusted by the wearer to give a reasonably comfortable fit typical of normal use.

5. *Exercise Regime.* Prior to entering the test chamber, the test subject shall be given complete instructions as to her/his part in the test procedures. The test subject shall perform the following exercises, in the order given, for each independent test.

a. *Normal Breathing (NB).* In the normal standing position, without talking, the subject shall breathe normally for at least one minute.

b. *Deep Breathing (DB).* In the normal standing position the subject shall do deep breathing for at least one minute pausing so as not to hyperventilate.

c. *Turning head side to side (SS).* Standing in place the subject shall slowly turn his/her head between the extreme positions from to side to side. The head shall be held at each extreme position for at least 5 seconds. Perform for at least three complete cycles.

d. *Moving head up and down (UD).* Standing in place, the subject shall slowly move his/her head up and down between the extreme position straight up and the extreme position straight down. The head shall be held at each extreme position for at least 5 seconds. Perform for at least three complete cycles.

e. *Reading (R).* The subject shall read out slowly and loud so as to be heard clearly by the test conductor or monitor. The test subject shall read the "rainbow passage" at the end of this section.

f. *Grimace (G).* The test subject shall grimace, smile, frown, and generally contort the face using the facial muscles. Continue for at least 15 seconds.

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g. *Bend over and touch toes (B).* The test subject shall bend at the waist and touch toes and return to upright position. Repeat for at least 30 seconds.

h. *Jogging in place (J).* The test subject shall perform jog in place for at least 30 seconds.

i. *Normal Breathing (NB).* Same as exercise a.

Rainbow Passage

When the sunlight strikes raindrops in the air, they act like a prism and form a rainbow. The rainbow is a division of white light into many beautiful colors. These take the shape of a long round arch, with its path high above, and its two ends apparently beyond the horizon. There is, according to legend, a boiling pot of gold at one end. People look, but no one ever finds it. When a man looks for something beyond his reach, his friends say he is looking for the pot of gold at the end of the rainbow.

6. The test shall be terminated whenever any single peak penetration exceeds 5% for half-masks and 1% for full facepieces. The test subject may be refitted and retested. If two of the three required tests are terminated, the fit shall be deemed inadequate. (See paragraph 4.h.)

7. *Calculation of Fit Factors.*

a. The fit factor determined by the quantitative fit test equals the average concentration inside the respirator.

b. The average test chamber concentration is the arithmetic average of the test chamber concentration at the beginning and of the end of the test.

c. The average peak concentration of the challenge agent inside the respirator shall be the arithmetic average peak concentrations for each of the nine exercises of the test which are computed as the arithmetic average of the peak concentrations found for each breath during the exercise.

d. The average peak concentration for an exercise may be determined graphically if there is not a great variation in the peak concentrations during a single excercise.

8. *Interpretation of Test Results.* The fit factor measured by the quantitative fit testing shall be the lowest of the three protection factors resulting from three independent tests.

9. *Other Requirements.*

a. The test subject shall not be permitted to wear a half-mask or full facepiece mask if the minimum fit factor of 100 or 1,000, respectively, cannot be obtained. If hair growth or apparel interfere with a satisfactory fit, then they shall be altered or removed so as to eliminate interference and allow a satisfactory fit. If a satisfactory fit is still not attained, the test subject must use a positive-pressure respirator such as powered air-purifying respirators, supplied air respirator, or self-contained breathing apparatus.

b. The test shall not be conducted if there is any hair growth between the skin and the facepiece sealing surface.

c. If a test subject exhibits difficulty in breathing during the tests, she or he shall be referred to a physician trained in respirator diseases or pulmonary medicine to determine whether the test subject can wear a respirator while performing her or his duties.

d. The test subject shall be given the opportunity to wear the assigned respirator for one week. If the respirator does not provide a satisfactory fit during actual use, the test subject may request another QNFT which shall be performed immediately.

e. A respirator fit factor card shall be issued to the test subject with the following information:

(1) Name.

(2) Date of fit test.

(3) Protection factors obtained through each manufacturer, model and approval number of respirator tested.

(4) Name and signature of the person that conducted the test.

f. Filters used for qualitative or quantitative fit testing shall be replaced weekly, whenever increased breathing resistance is encountered, or when the test agent has altered the integrity of the filter media. Organic vapor cartridges/canisters shall be replaced daily or sooner if there is any indication of breakthrough by the test agent.

10. In addition, because the sealing of the respirator may be affected, quantitative fit testing shall be repeated immediately when the test subject has a:

(1) Weight change of 20 pounds or more,

(2) Signficant facial scarring in the area of the facepiece seal,

(3) Signficant dental changes; i.e., multiple extractions without prosthesis, or acquiring dentures.

(4) Reconstructive or cosmetic surgery, or

(5) Any other condition that may interfere with facepiece sealing.

11. *Recordkeeping.*

A summary of all tests results shall be maintained for three years. The summary shall include:

(1) Name of test subject.

(2) Date of testing.

(3) Name of test conductor.

(4) Fit factors obtained from every respirator tested (indicate manufacturer, model, size and approval number).

Appendix D to §1910.1001 – Medical Questionnaires; Mandatory

This mandatory appendix contains the medical questionnaires that must be administered to all employees who are exposed to asbestos or a combination of these minerals above the action level, and who will therefore be included in their employer's medical surveillance program. Part 1 of the appendix contains the Initial Medical Questionnaire, which must be obtained for all new hires who will he covered by the medical surveillance requirements. Part 2 includes the abbreviated Periodical Medical Questionnaire, which must be administered to all employees who are provided periodic medical examinations under the medical surveillance provisions of the standard.

Part 1
INITIAL MEDICAL QUESTIONNAIRE

1. NAME_____
2. SOCIAL SECURITY # _ _ _ _ _ _ _ _ _
   1 2 3 4 5 6 7 8 9
3. CLOCK NUMBER _ _ _ _ _ _
4. PRESENT OCCUPATION_____
5. PLANT_____
6. ADDRESS_____
7. _____
   (Zip Code)
8. TELEPHONE NUMBER_____
9. INTERVIEWER_____
10. DATE_____
11. Date of Birth_____
    Month Day Year
12. Place of Birth_____
13. Sex
    1. Male ___
    2. Female ___
14. What is your marital status?
    1. Single ___
    2. Married ___
    3. Widowed ___
    4. Separated/Divorced ___
15. Race
    1. White ___
    2. Black ___
    3. Asian ___
    4. Hispanic ___
    5. Indian ___
    6. Other ___
16. What is the highest grade completed in school?_____
    (For example 12 years is completion of high school)
17. **OCCUPATIONAL HISTORY**

17A. Have you ever worked full time (30 hours per week or more) for six months or more?
    1. Yes ___
    2. No ___

    IF YES TO 17A:

B. Have you ever worked for a year or more in any dusty job?
    1. Yes ___
    2. No ___
    3. Does not apply ___

    Specify job/industry _____ Total Years Worked _____

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Was dust exposure:
1. Mild ___
2. Moderate ___
3. Severe ___

C. Have you ever been exposed to gas or chemical fumes in your work?
1. Yes ___
2. No ___

Specify job/industry _____ Total Years Worked _____

Was exposure:
1. Mild ___
2. Moderate ___
3. Severe ___

D. What has been your usual occupation or job—the one you have worked at the longest?
1. Job occupation _____
2. Number of years employed in this occupation _____
3. Position/job title _____
4. Business, field or industry _____

(Record on lines the years in which you have worked in any of these industries, e.g. 1960-1969)
Have you ever worked:

		YES	NO
E.	In a mine?	☐	☐
F.	In a quarry?	☐	☐
G.	In a foundry?	☐	☐
H.	In a pottery?	☐	☐
I.	In a cotton, flax or hemp mill?	☐	☐
J.	With asbestos?	☐	☐

18. PAST MEDICAL HISTORY

A.	Do you consider yourself to be in good health?	☐	☐
	If "NO" state reason _____		
B.	Have you any defect of vision?	☐	☐
	If "YES" state nature of defect _____		
C.	Have you any hearing defect?	☐	☐
	If "YES" state nature of defect _____		
D.	Are you suffering from or have you ever suffered from:		
a.	Epilepsy (or fits, seizures, convulsions)?	☐	☐
b.	Rheumatic fever?	☐	☐
c.	Kidney disease?	☐	☐
d.	Bladder disease?	☐	☐
e.	Diabetes?	☐	☐
f.	Jaundice?	☐	☐

19. CHEST COLDS AND CHEST ILNESSES

19A. If you get a cold, does it *usually* go to your chest? (Usually means more than ½ the time)
1. Yes ___
2. No ___
3. Don't get colds ___

20A. During the past 3 years, have you had any chest illnesses that have kept you off work, indoors at home, or in bed? _____

IF "YES" TO 20A:

B. Did you produce phlegm wiht any of these chest illnesses?
1. Yes ___
2. No ___
3. Does Not Apply ___

C. In the last 3 years, how many such illness with (increased) phlegm did you have which lasted a week or more?

Number of illnesses ___

No such illnesses ___

21. Did you have any lung trouble before the age of 16?

1. Yes ___
2. No ___

22. Have you ever had any of the following.

1A. Attacks of bronchitis?

1. Yes ___
2. No ___

IF YES TO 1A:

B. Was if confirmed by a doctor?

1. Yes ___
2. No ___
3. Does Not Apply ___

C. At what age was your first attack?

Age in Years ___

Does Not Apply ___

2A. Pneumonia (include bronchopneumonia)?

1. Yes ___
2. No ___

IF YES TO 2A:

B. Was it confirmed by a doctor?

1. Yes ___
2. No ___
3. Does Not Apply ___

C. At what age did you first have it?

Age in years ___

Does Not Apply ___

3A. Hay Fever?

1. Yes ___
2. No ___

IF YES TO 3A:

B. Was it confirmed by a doctor?

1. Yes ___
2. No ___
3. Does Not Apply ___

C. At what age did it start?

Age in years ___

Does Not Apply ___

23A. Have you ever had chronic bronchitis?

1. Yes ___
2. No ___

IF YES TO 23A:

B. Do you still have it?

1. Yes ___
2. No ___
3. Does Not Apply ___

C. Was it confirmed by a doctor?

1. Yes ___
2. No ___
3. Does Not Apply ___

D. At what age did it start?

Age in years ___

Does Not Apply ___

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24A. Have you ever had emphysema?
1. Yes ___
2. No ___

IF YES TO 24A:

B. Do you still have it?
1. Yes ___
2. No ___
3. Does Not Apply ___

C. At what age did it start?
Age in Years ___
Does Not Apply ___

25A. Have you ever had asthma?
1. Yes ___
2. No ___

IF YES TO 25A:

B. Do you still have it?
1. Yes ___
2. No ___
3. Does Not Apply ___

C. Was it confirmed by a doctor?
1. Yes ___
2. No ___
3. Does Not Apply ___

D. At what age did it start?
Age in Years ___
Does Not Apply ___

E. If you no longer have it, at what age did it stop?
Age stopped ___
Does Not Apply ___

26. Have you ever:

A. Any other chest illness?
1. Yes ___
2. No ___
If yes, please specify _____

B. Any chest operations?
1. Yes ___
2. No ___
If yes, please specify _____

C. Any chest injuries?
1. Yes ___
2. No ___
If yes, please specify _____

27A. Has a doctor ever told you that you had heart trouble?
1. Yes ___
2. No ___

IF YES TO 27A:

B. Have you ever had treatment for heart trouble in the past 10 years?
1. Yes ___
2. No ___
3. Does Not Apply ___

28A. Has a doctor ever told you that you had high blood pressure?
1. Yes ___
2. No ___

IF YES TO 28A:

B. Have you had any treatment for high blood pressure (hypertension) in the past 10 years?
   1. Yes ___
   2. No ___
   3. Does Not Apply ___

29. When did you last have your chest X-rayed? (Year) ___ ___ ___ ___

30. Where did you last have your chest X-rayed (if known)? _____

FAMILY HISTORY

31. Were either of your natural parents ever told by a doctor that they has a chronic lung condition such as:

	FATHER			MOTHER		
	1. Yes	2. No	3. Don't Know	1. Yes	2. No	3. Don't Know
A. Chronic Bronchitis?	___	___	___	___	___	___
B. Emphysema?	___	___	___	___	___	___
C. Asthma?	___	___	___	___	___	___
D. Lung Cancer	___	___	___	___	___	___
E. Other chest conditions	___	___	___	___	___	___
F. Is parent currently alive?	___	___	___	___	___	___
G. Please Specify	___ Age if living ___ Age at Death ___ Don't Know			___ Age if living ___ Age at Death ___ Don't Know		

H. Please specify cause of death

_____

COUGH

32A. Do you usually have a cough? (Count a cough with first smoke or on going out of doors. Exclude clearing of throat.) [If no, skip question 32C.]
   1. Yes ___
   2. No ___

B. Do you usually cough as much as 4 to 6 times a day 4 or more days out of the week?
   1. Yes ___
   2. No ___

C. Do you usually cough at all on getting up or first thing in the morning?
   1. Yes ___
   2. No ___

D. Do you usually cough at all during the rest of the day or at night?
   1. Yes ___
   2. No ___

IF YES TO ANY OF ABOVE (32A, B, C, or D), ANSWER THE FOLLOWING. IF NO TO ALL, CHECK DOES NOT APPLY AND SKIP TO NEXT PAGE.

E. Do you usually cough like this on most days for 3 consecutive months or more during the year?
   1. Yes ___
   2. No ___
   3. Does Not Apply ___

F. For how many years have you had the cough?
   Number of years ___
   Does not apply ___

33A. Do you usually bring up phlegm from your chest? (Count phlegm with the first smoke or on first going out of doors. Exclude phlegm from the nose. Count swallowed phlegm.) (If no, skip to 33C)
   1. Yes ___
   2. No ___

B. Do you usually bring up phelgm like as much as twice a day, 4 or more days out of the week?
   1. Yes ___
   2. No ___

Z

C. Do you usually bring up phlegm at all on getting up or first thing in the morning?
1. Yes ___
2. No ___

D. Do you usually bring up phlegm at all during the rest of the night?
1. Yes ___
2. No ___

IF YES TO ANY OF THE ABOVE (33A, B, C, or D), ANSWER THE FOLLOWING.
IF NO TO ALL, CHECK DOES NOT APPLY AND SKIP TO 34A.

E. Do you bring up phlegm like this on most days for 3 consecutive months or more during the year?
1. Yes ___
2. No ___
3. Does not apply ___

F. For how many years have you had trouble with phlegm?
Number of years ___
Does not apply ___

EPISODES OF COUGH AND PHLEGM

34A. Have you had periods or episodes of (increased*) cough and phelgm lasting for 3 weeks or more each year? *(For persons who usually have cough and/or phlegm)
1. Yes ___
2. No ___

IF YES TO 34A

B. For how long have you had at least 1 such episode per year?
Number of years ___
Does not apply ___

WHEEZING

35A. Does your chest ever sound wheezy or whistling

	YES	NO
1. When you have a cold?	☐	☐
2. Occasionally apart from cold?	☐	☐
3. Most days or nights?	☐	☐

IF YES TO 1, 2, or 3 in 35A

B. For how many years has this been present?
Number of years ___
Does not apply ___

36A. Have you ever had an attack of wheezing that has made you feel short of breath?
1. Yes ___
2. No ___

IF YES TO 36A

B. How old were you when you had your first such attack?
Age in years ___
Does not apply ___

C. Have you had 2 or more such episodes?
1. Yes ___
2. No ___
3. Does not apply ___

D. Have you ever required medicine or treatment for the(se) attack(s)?
1. Yes ___
2. No ___
3. Does not apply ___

BREATHLESSNESS

37. If disabled from walking by any condition other than heart or lung disease, please describe and proceed to question 39A.
Nature of condition(s) _____

38A. Are you troubled by shortness of breath when hurrying on the level or walking up a slight hill?
1. Yes ___
2. No ___
IF YES TO 38a

B. Do you have to walk slower than people of your age on the level because of breathlessness?
1. Yes ___
2. No ___
3. Does not apply ___

C. Do you ever have to stop for breath when walking at your own pace on the level?
1. Yes ___
2. No ___
3. Does not apply ___

D. Do you ever have to stop for breath after walking about 100 yards (or after a few minutes) on the level?
1. Yes ___
2. No ___
3. Does not apply ___

E. Are you too breathless to leave the house or breathless on dressing or climbing one flight of stairs?
1. Yes ___
2. No ___
3. Does not apply ___

TOBACCO SMOKING

39A. Have you ever smoked cigarettes? (No means less than 20 packs of cigaretts or 12 oz. of tobacco in a lifetime or less than 1 cigarette a day for 1 year.)
1. Yes ___
2. No ___
IF YES TO 39A

B. Do you now smoke cigarettes (as of one month ago)?
1. Yes ___
2. No ___

C. How old were you when you first started regular cigarette smoking?
Age in years ___
Does not apply ___

D. If you have stopped smoking cigarettes completely, how old were you when you stopped?
Age stopped ___
Check if still smoking ___
Does not apply ___

E. How many cigarettes do you smoke per day now?
Cigarettes per day ___
Does not apply ___

F. On the average of the entire time you smoked, how many cigarettes did you smoke per day?
Cigarettes per day ___
Does not apply ___

G. Do or did you inhale cigarette smoke?
1. Does not apply ___
2. Not at all ___
3. Slightly ___
4. Moderately ___
5. Deeply ___

40A. Have you ever smoked a pipe regularly? (Yes means more than 12 oz. of tobacco in a lifetime.)
1. Yes ___
2. No ___
IF YES TO 40A:

Z

FOR PERSONS WHO HAVE EVER SMOKED A PIPE

B. 1. How old were you when you started to smoke a pipe regularly?
Age ___
2. If you have stopped smoking a pipe completely, how old were you when you stopped?
Age stopped ___
Check if still smoking pipe ___
Does not apply ___

C. On the average over the entire time you smoked a pipe, how much pipe tobacco did you smoke per week?
___ oz. per week (a standard pouch of tobacco contains 1½ oz.)
___ Does not apply

D. How much pipe tobacco are you smoking now?
oz. per week ___
Not currently smoking a pipe ___

E. Do you or did you inhale the pipe smoke?
1. Never smoked ___
2. Not at all ___
3. Slightly ___
4. Moderately ___
5. Deeply ___

41A. Have you ever smoked cigars regularly? (Yes means more than 1 cigar a week for a year)
1. Yes ___
2. No ___

IF YES TO 41A:

FOR PERSONS WHO HAVE EVER SMOKED CIGARS

B. 1. How old were you when you started smoking cegars regularly?
Age ___
2. If you stopped smoking cigars completely, how old were you when you stopped?
Age stopped ___
Check if still smoking cigars ___
Does not apply ___

C. On the average over the entire time you smoked cigars, how many cigars did you smoke per week?
Cigars per week ___
Does not apply ___

D. How many cigars are you smoking per week now?
Cigars per week ___
Check if not smoking cigars currently ___

E. Do or did you inhale the cigars smoke?
1. Never smoked ___
2. Not at all ___
3. Slightly ___
4. Moderately ___
5. Deeply ___

Signature _____ Date _____

Part 1
PERIODIC MEDICAL QUESTIONNAIRE

1. NAME _____
2. SOCIAL SECURITY # ___ ___ ___ ___ ___ ___ ___ ___ ___
   1 2 3 4 5 6 7 8 9
3. CLOCK NUMBER ___ ___ ___ ___ ___ ___
4. PRESENT OCCUPATION _____
5. PLANT _____
6. ADDRESS _____
7. _____ (Zip Code)
8. TELEPHONE NUMBER _____
9. INTERVIEWER _____
10. DATE _____
11. What is your marital status?
    1. Single ___
    2. Married ___
    3. Widowed ___
    4. Separated/Divorced ___

OCCUPATIONAL HISTORY

12A. In the past year, did you work full time (30 hours per week or more) for 6 months or more?
    1. Yes ___
    2. No ___

    IF YES TO 12A:

B. In the past year, did you work in a dusty job?
    1. Yes ___
    2. No ___
    3. Does not apply ___

C. Was dust exposure:
    1. Mild ___
    2. Moderate ___
    3. Severe ___

D. In the past year, were you exposed to gas or chemical fumes in your work?
    1. Yes ___
    2. No ___

E. Was exposure:
    1. Mild ___
    2. Moderate ___
    3. Severe ___

F. In the past year, what was your:
    1. Job/occupation? _____
    2. Position job title? _____

RECENT MEDICAL HISTORY

13A. Do you consider yourself to be in good health?
    1. Yes ___
    2. No ___

    If NO, state reason _____

13B. In the past year, have you developed:

	Yes	No
Epilepsy?	☐	☐
Rheumatic fever?	☐	☐
Kidney disease?	☐	☐
Bladder disease?	☐	☐
Diabetes?	☐	☐
Jaundice?	☐	☐
Cancer?	☐	☐

Z

14. **CHEST COLDS AND CHEST ILLNESSES**

14A. If you get a cold, does it *usually* go to your chest? (Usually means more than ½ the time)

1. Yes ____
2. No ____
3. Don't get colds ____

15A. During the past year, have you had any chest illnesses that have kept you off work, indoors at home, or in bed?

1. Yes ____
2. No ____
3. Does not apply ____

IF YES TO 15A:

15B. Did you produce phlegm with any of these chest illnesses?

1. Yes ____
2. No ____
3. Does not apply ____

15C. In the past year, how many such illnesses with (increased) phlegm did you have which lasted a week or more?

Number of illnesses ____

No such illnesses ____

16. **RESPIRATORY SYSTEM**

In the past year you have had:

	Yes or No	Further Comment on Positive Answers
Asthma	____	
Bronchitis	____	
Hay Fever	____	
Other Allergies	____	

	Yes or No	Further Comment on Positive Answers
Pneumonia	____	
Tuberculosis	____	
Chest Surgery	____	
Other Lung Problems	____	
Heart Disease	____	

Do you have:

	Yes or No	Further Comment on Positive Answers
Frequent colds	____	
Chronic cough	____	
Shortness of breath when walking or climbing one flight or stairs	____	
Do you Wheeze	____	
Cough up phlegm	____	
Somke cigarettes	____	

Packs per day ____

How many year ____

Signature _____ Date _____

Appendix E to §1910.1001—Interpretation and Classification of Chest Roentgenograms—Mandatory

(a) Chest roentgenograms shall be interpreted and classified in accordance with a professionally accepted classification system and recorded on a Roentgenographic Interpretation Form. *Form CSD/NIOSH (M) 2.8.

(b) Roentgenograms shall be interpreted and classified only by a B-reader, a board eligible/certified radiologist, or an experienced physician with known expertise in pneumoconioses.

(c) All interpreters, whenever interpreting chest roentgenograms made under this section, shall have immediately available for reference a complete set of the ILO-U/C International Classification of Radiographs for Pneumoconioses, 1980.

Appendix F to § 1910.1001—Work Practices and Engineering Controls for Automotive Brake Repair Operations—Non-Mandatory

This appendix is intended as guidance for employers in the automotive brake and clutch repair industry who wish to reduce their employees' asbestos exposures during repair operations to levels below the new standard's action level (0.1 f/cc). OSHA believes that employers in this industry sector are likely to be able to reduce their employees' exposures to asbestos by employing the engineering and work practice controls described in Sections A and B of this appendix. Those employers who choose to use these controls and who achieve exposures below the action level will thus be able to avoid any burden that might be imposed by complying with such requirements as medical surveillance, recordkeeping, training, respiratory protection, and regulated areas, which are triggered when employee exposures exceed the action level or PEL.

Asbestos exposure in the automotive brake and clutch repair industry occurs primarily during the replacement of clutch plates and brake pads, shoes, and linings. Asbestos fibers may become airborne when an automotive mechanic removes the asbestos-containing residue that has been deposited as brakes and clutches wear. Employee exposures to asbestos occur during the cleaning of the brake drum or clutch housing.

Based on evidence in the rulemaking record (Exs. 84-74, 84-263, 90-148), OSHA believes that employers engaged in brake repair operations who implement any of the work practices and engineering controls described in Sections A and B of this appendix may be able to reduce their employees' exposures to levels below the action level (0.1 fiber/cc). These control methods and the relevant record evidence on these and other methods are described in the following sections.

A. Enclosed Cylinder/HEPA Vaccum System Method

The enclosed cylinder-vacuum system used in one of the facilities visited by representatives of the National Institute for Occupational Safety and Health (NIOSH) during a health hazard evaluation of brake repair facilities (Ex. 84-263) consists of three components:

(1) A wheel-shaped cylinder designed to cover and enclose the wheel assembly;

(2) A compressed-air hose and nozzle that fits into a port in the cylinder; and

(3) A HEPA-filtered vacuum used to evacuate airborne dust generated within the cylinder by the compressed air.

To operate the system, the brake assembly is enclosed in a cylinder that has viewing ports to provide visibility and cotton sleeves through which the mechanic can handle the brake assembly parts. The cylinder effectively isolates asbestos dust in the drum from the mechanic's breathing zone. The brake assembly isolation cylinder is available from the Nilfisk Company[1] and comes in two sizes to fit brake drums in the 7-to-12 inch size range common to automobiles and light trucks and the 12-to-19 inch size range common to large commercial vehicles. The cylinder is equipped with built-in compressed-air guns and a connection for a vacuum cleaner equipped with a High Efficiency Particulate Air (HEPA) filter. This type of filter is capable of removing all particles greater than 0.3 microns from the air. When the vacuum cleaner's filter is full, it must be replaced according to the manufacturer's instruction, and appropriate HEPA-filtered dual cartridge respirators should be worn during the process. The filter of the vacuum cleaner is assumed to be contaminated with asbestos fibers and should be handled carefully, wetted with a fine mist of water, placed immediately in a labelled plastic bag, and disposed of properly. When the cylinder is in place around the brake assembly and the HEPA vacuum is connected, compressed air is blown into the cylinder to loosen the residue from the brake assembly parts. The vacuum then evacuates the loosened material from within the cylinder, capturing the airborne material on the HEPA filter.

The HEPA vacuum system can be disconnected from the brake assembly isolation cylinder when the cylinder is not being used. The HEPA vacuum can then be used for clutch facing work, grinding, or other routine cleaning.

B. Compressed Air/Solvent System Method

A compressed-air hose fitted at the end with a bottle of solvent can be used to loosen the asbestos-containing residue and to capture the resulting airborne particles in the solvent mist. The mechanic should begin spraying the asbestos-contaminated parts with the solvent at a sufficient distance to ensure that the asbestos particles are not dislodged by the velocity of the solvent spray. After the asbestos particles are thoroughly wetted, the spray may be brought closer to the parts and the parts may be sprayed as necessary to remove grease and other material. The automotive parts sprayed with the mist are then wiped with a rag, which must then be disposed of appropriately. Rags should be placed in a labelled plastic bag or other container while they are still wet. This ensures that the asbestos fibers will not become airborne after the brake and clutch parts have been cleaned. (If cleanup rags are laundered rather than disposed of, they must be washed using methods appropriate for the laundering of asbestos-contaminated materials.)

OSHA believes that a variant of this compressed-air/solvent mist process offers advantages over the compressed-air/solvent mist technique discussed above, both in terms of costs and employee protection. The variant involves the use of spray cans filled with any of several solvent cleaners commercially available from auto supply stores. Spray cans of solvent are inexpensive, readily available, and easy to use. These cans will also save time, because no solvent delivery system has to be assembled, i.e., no compressed-air hose/mister ensemble. OSHA believes that a spray can will deliver

solvent to the parts to be cleaned with considerably less force than the alternative compressed-air delivery system described above, and will thus generate fewer airborne asbestos fibers than the compressed-air method. The Agency therefore believes that the exposure levels of automotive repair mechanics using the spray can/solvent mist process will be even lower than the exposures reported by NIOSH (Ex. 84-263) for the compressed-air/solvent mist system (0.08 f/cc).

C. Information on the Effectiveness of Various Control Measures

The amount of airborne asbestos generated during brake and clutch repair operations depends on the work practices and engineering controls used during the repair or removal activity. Data in the rulemaking record document the 8-hour time-weighted average (TWA_8) asbestos exposure levels associated with various methods of brake and clutch repair and removal.

NIOSH submitted a report to the record entitled "Health Hazard Evaluation for Automotive Brake Repair: (Ex. 84-263). In addition, Exhibits 84-74 and 90-148 provided exposure data for comparing the airborne concentrations of asbestos generated by the use of various work practices during brake repair operations. These reports present exposure data for brake repair operations involving a variety of controls and work practices, including:

- Use of compressed air to blow out the brake drums;
- Use of a brush, without a wetting agent, to remove the asbestos-containing residue;
- Use of a brush dipped in water or a solvent to remove the asbestos-containing residue;
- Use of an enclosed vacuum cleaning system to capture the asbestos-containing residue; and
- Use of a solvent mixture applied with compressed air to remove the residue.

Prohibited Methods

The use of compressed air to blow the asbestos-containing residue off the surface of the brake drum removes the residue effectively but simultaneously produces an airborne cloud of asbestos fibers. According to NIOSH (Ex. 84-263), the peak exposures of mechanics using this technique were as high as 15 fibers/cc, and 8-hour TWA exposures ranged from 0.03 to 0.19 f/cc.

Dr. William J. Nicholson of the Mount Sinai School of Medicine (Ex. 84-74) cited data from Knight and Hickish (1970) that indicated that the concentration of asbestos ranged from 0.84 to 5.35 f/cc over a 60-minute sampling period when compressed air was being used to blow out the asbestos-containing residue from the brake drum. In the same study, a peak concentration of 87 f/cc was measured for a few seconds during brake cleaning performed with compressed air. Rohl et al. (1976) (Ex. 90-148) measured are concentrations (of unspecified duration) within 3-5 feet of operations invpling the cleaning of brakes with compressed air and obtained readings ranging from 6.6 to 29.8 f/cc. Because of the high exposure levels that result from cleaning brake and clutch parts using compressed air, OSHA has prohibited this practice in the revised standard.

Ineffective Methods

When dry brushing was used to remove the asbestos-containing residue from the brake drums and wheel assemblies, peak exposures measured by NIOSH ranged from 0.61 to 0.81 f/cc, while 8-hour TWA levels were at the new standard's permissible exposure limit (PEL) of 0.2 f/cc (Ex. 84-263). Rohl and his colleagues (Ex. 90-148) collected area samples 1-3 feet from a brake cleaning operations being performed with a dry brush, and measured concentrations ranging from 1.3 to 3.6 f/cc; however, sampling times and TWA concentrations were not presented in the Rohl et al. study.

When a brush wetted with water, gasoline, or Stoddart solvent was used to clean the asbestos-containing residue from the affected parts, exposure levels (8-hour TWAs) measured by NIOSH also exceeded the new 0.2 f/cc PEL, and peak exposures ranged as high as 2.62 f/cc (Ex. 84-263).

Preferred Methods

Use of an engineering control system involving a cylinder that completely encloses the brake shoe assembly and a High Efficiency Particulate Air (HEPA) filter-equipped vacuum produced 8-hour TWA employee exposures of 0.01 f/cc and peak exposures ranging from nondetectable to 0.07 f/cc (Ex. 84-263). (Because this system achieved exposure levels below the standard's action level, it is described in detail below.) Data collected by the Mount Sinai Medical Center (Ex. 90-148) for Nilfisk of America, Inc., the manufacturer of the brake assembly enclosure system, showed that for two of three operations sampled. the exposure of mechanics to airborne asbestos fibers was nondetectable. For the third operator sampled by Mt. Sinai researchers, the exposure was 0.5 f/cc, which the authors attributed to asbestos that had contaminated the operator's clothing in the course of previous brake repair operations performed without the enclosed cylinder/vacuum system.

Some automotive repair facilities use a compressed-air hose to apply a solvent mist to remove the asbestos-containing residue from the brake drums before repair. The NIOSH data (Ex. 84-263) indicated that mechanics employing this method experienced exposures (8-hour TWAs) of 0.8 f/cc, with peaks of 0.25 to 0.68 f/cc. This techinque, and a variant of it that OSHA believes is both less costly and more effective in reducing employee exposures, is described in greater detail above in Sections A and B.

D. Summary

In conclusion, OSHA believes that it is likely that employers in the brake and clutch repair industry will be able to avail themselves of the action level trigger built into the revised standard if they conscientiously employ one of the three control methods described above: the enclosed cylinder/HEPA vacuum system, the compressed air/solvent method, or the spray can/solvent mist system.

Appendix G to § 1910.1001 – Substance Technical Information for Asbestos – Non-Mandatory

I. Substance Identification

A. Substance: "Asbestos" is the name of a class of magnesium-silicate minerals that occur in fibrous form. Minerals that are included in this group are chrysotile, crocidolite, amosite, tremolite asbestos, anthophyllite asbestos, and actinolite asbestos.

B. Asbestos is used in the manufacture of heat-resistant clothing, auto-motive brake and clutch linings, and a variety of building materials including floor tiles, roofing felts, ceiling tiles, asbestos-cement pipe and sheet, and tire-resistant drywall. Asbestos is also present in pipe and boiler insulation materials, and in sprayed-on materials located on beams, in crawlspaces, and between walls.

C. The potential for a product containing asbestos to release breatheable fibers depends on its degree of friability. Friable means that the material can be crumbled with hand pressure and is therefore likely to emit fibers. The fibrous or fluffy sprayed-on materials used for fireproofing, insulation, or sound proofing are considered to be friable, and they readily release airborne fibers if disturbed. Materials such as vinyl-asbestos floor tile or roofing felts are considered non-friable and generally do not emit airborne fibers unless subjected to sanding or sawing operations. Asbestos-cement pipe or sheet can emit airborne fibers if the materials are cut or sawed, or if they are broken during demolition operations.

D. Permissible exposure: Exposure to airborne asbestos fibers may not exceed 0.2 fibers per cubic centimeter of air (0.2 f/cc) averaged over the 8-hour workday.

II. Health Hazard Data

A. Asbestos can cause disabling respiratory disease and various types of cancers if the fibers are inhaled. Inhaling or ingesting fibers from contaminated clothing or skin can also result in these diseases. The symptoms of these diseases generally do not appear for 20 or more years after initial exposure.

B. Exposure to asbestos has been shown to cause lung cancer, mesothelioma, and cancer of the stomach and colon. Mesothelioma is a rare cancer of the thin membrane lining of the chest and abdomen. Symptoms of mesothelioma include shortness of breath, pain in the walls of the chest, and/or abdominal pain.

III. Respirators and Protective Clothing

A. Respirators: You are required to wear a respirator when performing tasks that result in asbestos exposure that exceeds the permissible exposure limit (PEL) of 0.2 f/cc. These conditions can occur while your employer is in the process of installing engineering controls to reduce asbestos exposure, or where engineering controls are not feasible to reduce asbestos exposure. Air-purifying respirators equipped with a high-efficiency particulate air (HEPA) filter can be used where airborne asbestos fiber concentrations do not exceed 2 f/cc; otherwise, air-supplied, positive-pressure full-facepiece respirators must be used. Disposable respirators or dust masks are not permitted to be used for asbestos work. For effective protection, respirators must fit your face and head snugly. Your employer is required to conduct fit tests when you are first assigned a respirator and every six months thereafter. Respirators should not be loosened or removed in work situations where their use is required.

B. Protective Clothing: You are required to wear protective clothing in work areas where asbestos fiber concentrations exceed the permissible exposure limit (PEL) of 0.2 f/cc to prevent contamination of the skin. Where protective clothing is required, your employer must provide you with clean garments. Unless you are working on a large asbestos removal or demolition project, your employer must also provide a change room and separate lockers for your street clothes and contaminated work clothes. If you are working on a large asbestos removal or demolition project, and where it is feasible to do so, your employer must provide a clean room, shower, and decontamination room contiguous to the work area. When leaving the work area you must remove contaminated clothing before proceeding to the shower. If the shower is not adjacent to the work area you must vacuum your clothing before proceeding to the change room and shower. To prevent inhaling fibers in contaminated change rooms and showers, leave your respirator on until you leave the shower and enter the clean change room.

IV. Disposal Procedures and Cleanup

A. Wastes that are generated by processes where asbestos is present include:

1. Empty asbestos shipping containers.
2. Process wastes such as cuttings, trimmings, or reject material.
3. Housekeeping waste from sweeping or vacuuming.
4. Asbestos fireproofing or insulating material that is removed from buildings.
5. Building products that contain asbestos removed during building renovation or demolition.
6. Contaminated disposable protective clothing.

B . Empty shipping bags can be flattened under exhaust hoods and packed into airtight containers for disposal. Empty shipping drums are difficult to clean and should be sealed.

C. Vacuum logs or disposable paper filters should not be cleaned, but should be sprayed with a fine water mist and placed into a labeled waste container.

D. Process waste and housekeeping waste should be wetted with water or a mixture of water and surfactant prior to packaging in disposable containers.

E. Material containing asbestos that is removed from buildings must be disposed of in leak-tight 6-mil thick plastic bags plastic-lined cardboard containers, or plastic-lined card-board containers, or plastic-lined metal containers. These wastes, which are removed while wet, should be sealed in containers before they dry out to minimize the release if asbestos fibers during handling.

V. Access to Information

A. Each year, your employer is required to inform you of information contained in this standard and appendices for asbestos. In addition, your employer must instruct you in the proper work practices for handling material containing asbestos and the correct use of protective equipment.

B. Your employer is required to determine whether you are being exposed to asbestos. You or your representative has the right to observe employee measurements and to record the results obtained. Your employer is required to inform you of your exposure, and, if you are exposed above the permissible limit, he or she is required to inform you of the actions that are being taken to reduce your exposure to within the permissible limit.

C. Your employer is required to keep records of your exposures and medical examinations. These exposure records must be kept for at least thirty (30) years. Medical records must be kept for the period of your employment plus thirty (30) years.

D. Your employer is required to release your exposure and medical records to your physician or designated representative upon your written request.

Appendix H to §1910.1001 – Medical Surveillance Guidelines for Asbestos – Non-Mandatory

I. Route of Entry: Inhalation, Ingestion

II. Toxicology

Clinical evidence of the adverse effects associated with exposure to asbestos is present in the form of several well-conducted epidemiological studies of occupationally exposed workers, family contacts of workers, and persons living near asbestos mines. These studies have shown a definite association between exposure to asbestos and an increased incidence of lung cancer, pleural and peritoneal mesothelioma, gastrointestinal cancer and asbestosis. The latter is a disabling fibrotic lung disease that is caused only by exposure to asbestos. Exposure to asbestos has been associated with an increased incidence of esophageal, kidney, laryngeal, pharyngeal, and buccal cavity cancers. As with other known chronic occupational diseases, disease associated with asbestos generally appears about 20 years following the first occurrence of exposure: There are no known acute effects associated with exposure to asbestos.

Epidemiological studies indicate that the risk of lung cancer among exposed workers who smoke cigarettes is greatly increased over the risk of lung cancer among non-exposed smokers or exposed nonsmokers. These studies suggest that cessation of smoking will reduce the risk of lung cancer for a person exposed to asbestos but will not reduce it to the same level of risk as that existing for an exposed worker who has never smoked.

III. Signs and Symptoms of Exposure-Related Disease

The signs and symptoms of lung cancer or gastrointestinal cancer induced by exposure to asbestos are not unique, except that a chest X-ray of an exposed patient with lung cancer may show pleural plaques, pleural calcification, or pleural fibrosis. Symptoms characteristic of mesothelioma include shortness of breath, pain in the walls of the chest, or abdominal pain. Mesothelioma has a much longer latency period compared with lung cancer (40 years verus 15-20 years), and mesothelioma is therefore more likely to be found among workers who were first exposed to asbestos at an early age. Mesothelioma is always fatal.

Asbestosis is pulmonary fibrosis caused by the accumulation of asbestos fibers in the lungs. Symptoms include shortness of breath, coughing, fatigue, and vague feelings of sickness. When the fibrosis worsens, shortness of breath occurs even at rest. The diagnosis of asbestosis is based on a history of exposure to asbestos, the presence of characteristic radiologic changes, end-respiratory crackles (rales), and other clinical features of fibrosing lung disease. Pleural plaques and thickening are observed on X-rays taken during the early stages of the disease. Asbestosis is often a progressive disease even in the absence of continued exposure, although this appears to be a highly individualized characteristic. In severe cases, death may be caused by respiratory or cardiac failure.

IV. Surveillance and Preventive Considerations

As noted above, exposure to asbestos has been linked to an increased risk of lung cancer, mesothelioma, gastrointestinal cancer, and asbestosis among occupationally exposed workers. Adequate screening tests to determine an employee's potential for developing serious chronic diseases, such as cancer, from exposure to asbestos do not presently exist. However, some tests, particularly chest X-rays and pulmonary function tests, may indicate that an employee has been overexposed to asbestos increasing his or her risk of developing exposure-related chronic diseases. It is important for the physician to become familiar with the operating conditions in which occupational exposure to asbestos is likely to occur. This is particularly important in evaluating medical and work histories and in conducting physical examinations. When an active employee has been identified as having been overexposed to asbestos, measures taken by the employer to eliminate or mitigate further exposure should also lower the risk of serious long-term consequences.

The employer is required to institue a medical surveillance program for all employees who are or will be exposed to asbestos at or above the action level (0.1 fiber per cubic centimeter of air) for 30 or more days per year and for all employees who are assigned to wear a negative-pressure respirator. All examinations and procedures must be performed by or under the supervision of a licensed physician, at a reasonable time and place, and at no cost to the employee.

Although broad latitude is given to the physician in prescribing specific tests to be includes in the medical surveillance program. OSHA requires inclusion of the following elements in the routine examination:

(i) Medical and work histories with special emphasis directed to symptoms of the respiratory system, cardiovascular system, and digestive tract.

(ii) Completion of the respiratory disease questionnaire contained in Appendix D.

(iii) A physical examination including a chest roentgenogram and pulmonary function test that includes measurement of the employee's forced vital capacity (FVC) and forced expiratory volume at one second (FEV_1).

(iv) Any laboratory or other test that the examining physician deems by sound medical practice to be necessary.

The employer is required to make the prescribed tests available at least annually to those employees covered; more often than specified if recommended by the examining physician; and upon termination of employment.

The employer is required to provide the physician with the following information: A copy of this standard and appendices; a description of the employee's duties as they relate to asbestos exposure; the employer's representative level of exposure to asbestos; a description of any personal protective and respiratory equipment used; and information

from previous medical examinations of the affected employee that is not otherwise available to the physician. Making this information available to the physician will aid in the evaluation of the employee's health in relation to assigned duties and fitness to wear personal protective equipment, if required.

The employer is required to obtain a written opinion from the examining physician containing the results of the medical exammation; the physician's opinion as to whether conditions that would place the employee at an increased risk of exposure-related disease; any recommended limitations on the employee or on the use of personal protective equipment; and a statement that the employee has been informed by the physician of the results of the medical examination and of any medical conditions related to asbestos exposure that require further explanation or treatment. This written opinion must not reveal specific findings or diagnosis unrelated to exposure to asbestos, and a copy of the opinion must be provided to the affected employee.

Vinyl Chloride — 1910.1017

Atmospheric concentration of vinyl chloride	*Required apparatus*
(i) Unknown, or above 3,600 ppm	Open-circuit, self-contained breathing apparatus, pressure demand type, with full facepiece.
(ii) Not over 3,600 ppm	(a) Combination type C supplied air respirator, pressure demand type, with full or half facepiece, and auxiliary self-contained air supply; or (b) Combination type C, supplied air respirator, continuous flow type, with full or half facepiece and auxiliary self-contained air supply.
(iii) Not over 1,000 ppm	Type C, supplied air respirator continuous flow type, with full or half facepiece, helmet or hood.
(iv) Not over 100 ppm	(a) Combination type C supplied air respirator demand type, with full facepiece, and auxiliary self-contained air supply; or (b) Open-circuit self-contained breathing apparatus with full facepiece, in demand mode; or (c) Type C supplied air respirator, demand type, with full facepiece.
(v) Not over 25 ppm	(a) A powered air-purifying respirator with hood, helmet, full or half facepiece, and a canister which provides a service life of at least 4 hours for concentrations of vinyl chloride up to 25 ppm, or (b) Gas mask, front- or back-mounted canister which provides a service life of at least 4 hours for concentrations of vinyl chloride up to 25 ppm.
(iv) Not over 10 ppm	(a) Combination type C supplied-air respirator, demand type, with half facepiece, and auxiliary self-contained air supply; or (b) Type C supplied-air respirator, demand type, with half facepiece; or (c) Any chemical cartridge respirator with an organic vapor cartridge which provides a service life of at least 1 hour for concentrations of vinyl chloride up to 10 ppm.

APPENDIX A — SUPPLEMENTARY MEDICAL INFORMATION

When required tests under paragraph (k)(l) of this section show abnormalities, the tests should be repeated as soon as practicable, preferably within 3 to 4 weeks. If tests remain abnormal, consideration should be given to withdrawal of the employee from contract with vinyl chloride, while a more comprehensive examination is made.

Additional tests which may be useful:

A. For kidney dysfunction: urine examination for albumin, red blood cells, and exfoliative abnormal cells.

B. Pulmonary system: Forced vital capacity. Forced expiratory volume at 1 second, and chest roentgenogram (posterior-anterior, 14 x 17 inches).

C. Additional serum tests: Lactic acid dehydrogenase, lactic acid dehydrogenase isoenzyme, protein determination, and protein electrophoresis.

D. For a more comprehensive examination on repeated abnormal serum tests: Hepatitis B antigen, and liver scanning.

[39 F.R. 35889, October 4, 1974.]

APPENDIX A – INORGANIC ARSENIC SUBSTANCE INFORMATION SHEET

I. SUBSTANCE IDENTIFICATION

A. *Substance.* Inorganic Arsenic.

B. *Definition.* Copper acetoarsenite, arsenic and all inorganic compounds containing arsenic except arsine, measured as arsenic (As).

C. *Permissible Exposure Limit.* 10 micrograms per cubic meter of air as determined as an average over an 8-hour period. No employee may be exposed to any skin or eye contact with arsenic trichloride or to skin or eye contact likely to cause skin or eye irritation.

D. *Regulated Areas.* Only employees authorized by your employer should enter a regulated area.

II. HEALTH HAZARD DATA

A. *Comments.* The health hazard of inorganic arsenic is high.

B. *Ways in which the chemical affects your body.* Exposure to airborne concentrations of inorganic arsenic may cause lung cancer, and can be a skin irritant. Inorganic arsenic may also affect your body if swallowed. One compound in particular, arsenic trichloride, is especially dangerous because it can be absorbed readily through the skin. Because inorganic arsenic is a poison, you should wash your hands thoroughly prior to eating or smoking.

III. PROTECTIVE CLOTHING AND EQUIPMENT

A. *Respirators.* Respirators will be provided by your employer at no cost to you for routine use if your employer is in the process of implementing engineering and work practice controls or where engineering and work practice controls are not feasible or insufficient. You must wear respirators for non-routine activities or in emergency situations where you are likely to be exposed to levels of inorganic arsenic in excess of the permissible exposure limit. Since how well your respirator fits your face is very important, your employer is required to conduct fit tests to make sure the respirator seals properly when you wear it. These tests are simple and rapid and will be explained to you during training sessions.

B. *Protective clothing.* If you work in a regulated area, your employer is required to provide at no cost to you, and you must wear, appropriate, clean, protective clothing and equipment. The purpose of this equipment is to prevent you from bringing to your home arsenic-contaminated dust and to protect your body from repeated skin contact with inorganic arsenic likely to cause skin irritation. This clothing should include such items as coveralls or similar full-body clothing, gloves, shoes or coverlets, and aprons. Protective equipment should include face shields or vented goggles, where eye irritation may occur.

IV. HYGIENE FACILITIES AND PRACTICES

You must not eat, drink, smoke, chew gum or tobbacco, or apply cosmetics in the regulated area, except that drinking water is permitted. If you work in a regulated area your employer is required to provide lunchrooms and other areas for these purposes.

If you work in a regulated area, your employer is required to provide showers, washing facilties, and change rooms. You must wash your face, and hands before eating and must shower at the end of the work shift. Do not take used protective clothing out of change rooms without your employer's permission. Your employer is required to provide for laundering or cleaning of your protective clothing.

V. SIGNS AND LABELS

Your employer is required to post warning signs and labels for your protection. Signs must be posted in regulated areas. The signs must warn that a cancer hazard is present, that only authorized employees may enter the area, and that no smoking or eating is allowed, and that respirators must be worn.

VI. MEDICAL EXAMINATIONS

If your exposure to arsenic is over the Action Level (5 $\mu g/m^3$)—(including all persons working in regulated areas) at least 30 days per year, or you have been exposed to arsenic for more than 10 years over the Action Level, your employer is required to provide you with a medical examination. The examination shall be every 6 months for employees over 45 years old or with more than 10 years exposure over the Action Level and annually for other covered employees. The medical examination must include a medical history; a chest x-ray; skin examination; nasal examination and sputum cytology exam for the early detection of lung cancer. The cytology exams are only included in the initial exam and examinations given after you are either 45 years or older or have 10 or more years employment over the Action Level. The examining physician will provide a written opinion to your employer containing the results of the medical exams. You should also receive a copy of this opinion. The physician must not tell your employer any conditions he detects unrelated to occupational exposure to arsenic but must tell you those conditions.

VII. OBSERVATION OF MONITORING

Your employer is required to monitor your exposure to arsenic and you or your representatives are entitled to observe the monitoring procedure. You are entitled to receive an explanation of the measurement procedure, and to record the results obtained. When the monitoring procedure is taking place in an area where respirators or personal protective clothing and equipment are required to be worn, you must also be provided with and must wear the protective clothing and equipment.

VIII. ACCESS TO RECORDS

You or your representative are entitled to records of your exposure to inorganic arsenic upon request to your employer. Your medical examination records can be furnished to your physician if you request your employer to provide them.

IX. TRAINING AND NOTIFICATION

Additional information on all of these items plus training as to hazards of exposure to inorganic arsenic and the engineering and work practice controls associated with your job will also be provided by your employer. If you are exposed over the permissible exposure limit, your employer must inform you of that fact and the actions he is taking to reduce your exposures.

Z

ARSENIC, ARSENIC TRIOXIDE, ARSENIC TRICHLORIDE (THREE EXAMPLES)

I. Physical and chemical properties

A. Arsenic (metal).

1. Formula: As.

2. Appearance: Gray metal.

3. Melting point: Sublimes without melting at 613C.

4. Specific Gravity: (H20=1):5.73.

5. Solubility in water: Insoluble.

B. Arsenic Trioxide.

1. Formula: As203, (As406).

2. Appearance: White powder.

3. Melting point: 315C.

4. Specific Gravity (H20=1):3.74.

5. Solubility in water: 3.7 grams in 100cc of water at 20c.

C. Arsenic Trichloride (liquid).

1. Formula: AsC13.

2. Appearance: Colorless or pale yellow liquid.

3. Melting point: −8.5C

4. Boiling point: 130.2C.

5. Specific Gravity (H20=1):2.16 at 20C.

6. Vapor Pressure: 10mm Hg at 23.5C.

7. Solubility in Water: Decomposes in water.

II. Fire, explosion and reactivity data

A. Fire: Arsenic, arsenic Trioxide and Arsenic Trichloride are nonflammable.

B. Reactivity:

1. Conditions Contributing to instability: Heat.

2. Incompatibility: Hydrogen gas can react with inorganic arsenic to form the highly toxic gas arsine.

III. Monitoring and Measurement Procedures.

Samples collected should be full shift (at least 7-hour) samples. Sampling should be done using a personal sampling pump at a flow rate of 2 liters per minute. Samples should be collected on 0.8 micrometer pore size membrane filter (37mm diameter). Volatile arsenicals such as arsenic trichloride can be most easily collected in a midget bubbler filled with 15 ml of 0.1 N NaOH.

The method of sampling and analysis should have an accuracy of not less than ±25 percent (with a confidence limit of 95 percent) for 10 micrograms per cubic meter of air (10 $\mu g/m^3$) and ±35 percent (with a confidence limit of 95 percent) for concentrations of inorganic arsenic between 5 and 10 $\mu g/m^3$.

APPENDIX C – MEDICAL SURVEILLANCE GUIDELINES

I. GENERAL

Medical examinations are to be provided for all employees exposed to levels of inorganic arsenic above the action level (5 $\mu g/m^3$) for at least 30 days per year (which would include among others, all employees, who work in regulated areas). Examinations are also to be provided to all employees who have had 10 years or more exposure above the action level for more than 30 days per year while working for the present or predecessor employer though they may no longer be exposed above the level.

An initial medical examination is to be provided to all such employees by December 1, 1978. In addition, an initial medical examination is to be provided to all employees who are first assigned to areas in which worker exposure will probably exceed 5 $\mu g/m^3$ (after the effective date of this standard) at the time of initial assignment. In addition to its immediate diagnostic usefulness, the initial examination will provide a baseline for comparing future test results. The initial examination must include as a minimum the following elements:

(1) A work and medical history, including a smoking history, and presence and degree of respiratory symptoms such as breathlessness, cough, sputum production, and wheezing;

(2) A 14" by 17" posterior-anterior chest X-ray and an International Labor Office UICC/Cincinnati (ILO U/C) rating;

(3) A nasal and skin examination;

(4) A Sputum Cytology examination; and

(5) Other examinations which the physician believes appropriate because of the employee's exposure to inorganic arsenic or because of required respirator use.

Periodic examinations are also to be provided to the employees listed above. The periodic examinations shall be given annually for those covered employees 45 years of age or less with fewer than 10 years employment in areas where employee exposure exceeds the action level (5 $\mu g/m^3$). Periodic examinations need not include sputum cytology and only an updated medical history is required.

Periodic examinations for other covered employees, shall be provided every six (6) months. These examinations shall include all tests required in the initial examination, except that the medical history need only be updated.

The examination and contents are minimum requirements. Additional tests such as lateral and oblique X-rays or pulmonary function tests may be useful. For workers exposed to three arsenicals which are associated with lymphatic cancer, copper acetoarsenite, potassium arsenite, or sodium arsenite the examination should also include palpation of superficial lymph nodes and complete blood count.

II. NONCARCINOGENIC EFFECTS

The OSHA standard is based on minimizing the risk of exposed workers dying of lung cancer from exposure to inorganic arsenic. It will also minimize skin cancer from such exposures.

The following three sections quoted from "Occupational Diseases: A Guide to Their Recognition", Revised Edition, June 1977, National Institute for Occupational Safety and Health is included to provide information on the nonneoplastic effects of exposure to inorganic arsenic. Such effects should not occur if the OSHA standards are followed.

A. *Local*—Trivalent arsenic compounds are corrosive to the skin. Brief contact has no effect but prolonged contact results in a local hyperemia and later vesicular or pustular eruption. The moist mucous membranes are most sensitive to the irritant action. Conjunctiva, moist and macerated areas of skin, the eyelids, the angles of the ears, nose, mouth, and respiratory mucosa are also vulnerable to the irritant effects. The wrists are common sites of dermatitis, as are the genitalia if personal hygiene is poor. Perforations of the nasal septum may occur. Arsenic trioxide and pentoxide are capable of producing skin sensitization and contact dermatitis. Arsenic is also capable of producing keratoses, especially of the palms and soles.

B. *Systemic*—The acute toxic effects of arsenic are generally seen following ingestion of inorganic arsenical compounds. This rarely occurs in an industrial setting. Symptoms develop within ½ to 4 hours following ingestion and are usually characterized by constriction of the throat followed by dysphagia, epigastric pain, vomiting, and watery diarrhea. Blood may appear in vomitus and stools. If the amount ingested is sufficiently high, shock may develope due to severe fluid loss, and death may ensue in 24 hours. If the acute effects are survived, exfoliative dermatitis and peripheral neuritis may develop.

Cases of acute arsenical poisoning due to inhalation are exceedingly rare in industry. When it does occur, respiratory tract symptoms—cough, chest pain, dyspnea—giddiness, headache, and extreme general weakness precede gastrointestinal symptoms. The acute toxic symptoms of trivalent arsenical poisoning are due to severe inflammation of the mucous membranes and greatly increased permeability of the blood capillaries.

Chronic arsenical poisoning due to ingestion is rare and generally confined to patients taking prescribed medications. However, it can be a concomitant of inhaled inorganic arsenic from swallowed sputum and improper eating habits. Symptoms are weight loss, nausea and diarrhea alternating with constipation, pigmentation and eruption of the skin, loss of hair, and peripheral neuritis. Chronic hepatitis and cirrhosis have been described. Polyneuritis may be the salient feature, but more frequently there are numbness and parasthenias of "glove and stocking" distribution. The skin lesions are usually melanotic and keratotic and may occasionally take the form of an intradermal cancer of the squamous cell type, but without infiltrative properties. Horizontal white lines (striations) on the fingernails and toenails are commonly seen in chronic arsenical poisoning and are considered to be a diagnostic accompaniment of arsenical polyneuritis.

Inhalation of inorganic arsenic compounds is the most common cause of chronic poisoning in the industrial situation. This condition is divided into three phases based on signs and symptoms.

First Phase: the worker complains of weakness, loss of appetite, some nausea, occasional vomiting, a sense of heaviness in the stomach, and some diarrhea.

Second Phase: The worker complains of conjunctivitis, a catarrhal state of the mucuous membranes of the nose, larynx, and respiratory passage. Coryza, hoarseness, and mild tracheobronchitis may occur. Perforation of the nasal septum is common, and is probably the most typical lesion of the upper respiratory tract in occupational exposure to arsenical dust. Skin lesions, eczematoid and allergic in type, are common.

Third Phase: The worker complains of symptoms of peripheral neuritis, initially of hands and feet, which is essentially sensory. In more severe cases, motor paralyses occur; the first muscles affected are usually the toe extensors and the peronei. In only the most severe cases will paralysis of flexor muscles of the feet or of the extensor muscles of hands occur.

Liver damage from chronic arsenical poisoning is still debated, and as yet the question is unanswered. In cases of chronic and acute arsenical poisoning, toxic effects to the myocardium have been reported based on EKG changes. These findings, however, are now largely discounted and the EKG changes are ascribed to electrolyte disturbances concomitant with arsenicalism. Inhalation of arsenic trioxide and other inorganic arsenical dusts does not give rise to radiological evidence or pneumonconiosis. Arsenic does have a depressant effect upon the bone marrow, with disturbances of both erythropoiesis and myelopoiesis.

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III. SPUTUM CYTOLOGY

Sputum can be collected by aerosol inhalation during the medical exam or by spontaneous early morning cough at home. Sputum is induced by transoral inhalation of an aerosolized solution of 8% sodium chloride in water. After inhaling as few as three to five breaths the subject usually yields an adequate sputum. All sputum should be collected directly into 60% alcohol.

Scientific evidence suggests that chest X-rays and sputum cytology should be used together as screening tests for lung tests for lung cancer in high risk populations such as workers exposed to inorganic arsenic. The tests are to be performed every six months on workers who are 45 years of age or older or have worked in the regulated area for 10 or more years. Since the tests seem to be complementary, it may be advantageous to alternate the test procedures. For instance, chest X-rays could be obtained in June and December and sputum cytologies could be obtained in March and September. Facilities for providing necessary diagnostic investigation should be readily available as well as chest physicians, surgeons, radiologists, pathologists and immunotherapists to provide any necessary treatment services.

[43 F.R. 19624, May 5, 1978 and corrected at 43 F.R,. 28472, June 30, 1978.]

APPENDIX A — SUBSTANCE DATA SHEET

I. Substance Identification

A. *Substance:* Pure lead (Pb) is a heavy metal at room temperature and pressure and is a basic chemical element. It can combine with various other substances to form numerous lead compounds.

B. *Compounds Covered by the Standard:* The word "lead" when used in this standard means elemental lead, all inorganic lead compounds and a class of organic lead compounds called lead soaps. This standard does not apply to other organic lead compounds.

C. *Uses:* Exposure to lead occurs in at least 120 different occupations, including primary and secondary lead smelting, lead storage battery manufacturing, lead pigment manufacturing and use, solder manufacturing and use, shipbuilding and ship repairing, auto manufacturing, and printing.

D. *Permissible Exposure:* The Permissible Exposure Limit (PEL) set by the standard is 50 micrograms of lead per cubic meter of air (50μg/m^3), averaged over an 8-hour work-day.

E. *Action Level:* The standard establishes an action level of 30 micrograms per cubic meter of air (30 μg/m^3), time weighted average, based on an 8-hour work-day. The action level initiates several requirements of the standard, such as exposure monitoring, medical surveillance, and training and education.

II. Health Hazard Data

A. *Ways in which lead enters your body.* When absorbed into your body in certain doses lead is a toxic substance. The object of the lead standard is to prevent absorption of harmful quantities of lead. The standard is intended to protect you not only from the immediate toxic effects of lead, but also from the serious toxic effects that may not become apparent until years of exposure have passed.

Lead can be absorbed into your body by inhalation (breathing) and ingestion (eating). Lead (except for certain organic lead compounds not covered by the standard, such as tetraethyl lead) is not absorbed through your skin. When lead is scattered in the air as a dust, fume or mist it can be inhaled and absorbed through your lungs and upper respiratory tract. Inhalation of airborne lead is generally the most important source of occupational lead absorption. You can also absorb lead through your digestive system if lead gets into you mouth and is swallowed. If you handle food, cigarettes, chewing tobacco, or make-up which have lead on them or handle them with hands contaminated with lead, this will contribute to ingestion.

A significant portion of the lead that you inhale or ingest gets into your blood stream. Once in your blood stream, lead is circulated throughout your body and stored in various organs and body tissues. Some of this lead is quickly filtered out of your body and excreted, but some remains in the blood and other tissues. As exposure to lead continues, the amount stored in your body will increase if you are absorbing more lead than your body is excreting. Even though you may not be aware of any immediate symptoms of disease, this lead stored in your tissues can be slowly causing irreversible damage, first to individual cells, then to your organs and whole body systems.

B. *Effects of overexposure to lead* – (1) *Short term (acute) overexposure.* Lead is a potent, systemic poison that serves no known useful function once absorbed by your body. Taken in large enough doses, lead can kill you in a matter of days. A condition affecting the brain called acute encephalopathy may arise which develops quickly to seizures, coma, and death from cardio-respiratory arrest. A short term dose of lead can lead to acute encephalopathy. Short term occupational exposures of this magnitude are highly unusual, but not impossible. Similar forms of encephalopathy may, however, arise from extended, chronic exposure to lower doses of lead. There is no sharp dividing line between rapidly developing acute effects of lead, and chronic efects which take longer to acquire. Lead adversely affects numerous body systems, and causes forms of health impairment and disease which arise after periods of exposure as short as days or as long as several years.

(2) *Long-term (chronic) overexposure.* Chronic overexposure to lead may result in severe damage to your blood-forming, nervous, urinary and reproductive systems. Some common symptoms of chronic overexposure include loss of appetite, metallic taste in the mouth, anxiety, constipation, nausea, pallor, excessive tiredness, weakness, insomina, headache, nervous irritability, muscle and joint pain or soreness, fine tremors, numbness, dizziness, hyperactivity and colic. In lead colic there may be severe abdominal pain.

Damage to the central nervous system in general and the brain (encephalopathy) in particular is one of the most severe forms of lead poisoning. The most severe, often fatal, form of encephalopathy may be preceded by vomiting, a feeling of dullness, progressing to drowsiness and stupor, poor memory, restlessness, irritability, tremor, and convulsions. It may arise suddenly with the onset of seizures, followed by coma, and death. There is a tendency for muscular weakness to develop at the same time. This weakness may progress to paralysis often observed as a characteristic "wrist drop" or "foot drop" and is a manifestation of a disease to the nervous system called peripheral neuropathy.

Chronic overexposure to lead also results in kidney disease with few, if any, symptoms appearing until extensive and most likely permanent kidney damage has occurred. Routine laboratory tests reveal the presence of this kidney disease after about two-thirds of kidney function is lost. When overt symptoms of urinary dysfunctions arise, if is often too late to correct or prevent worsening conditions, and progression to kidney dialysis or death is possible.

Chronic overexposure to lead impairs the reproductive systems of both men and women. Overexposure to lead may result in decreased sex drive, impotence and sterility in men. Lead can alter the structure of sperm cells raising the risk of birth defects. There is evidence of miscarriage and stillbirth in women whose husbands were exposed to lead or who were exposed to lead themselves. Lead exposure also may result in decreased fertility, and abnormal menstrual cycles in women. The course of pregnancy may be adversely affected by exposure to lead since lead crosses the placental barrier and poses risks to developing fetuses. Children born of parents, either one of whom were exposed to excess lead levels are more likely to have birth defects, mental retardation, behavioral disorders or die during the first year of childhood.

Overexposure to lead also disrupts the blood-forming system resulting in decreased hemoglobin (the substance in the blood that carries oxygen to the cells) and ultimately anemia. Anemia is characterized by weakness, pallor and fatigability as a result of decreased oxygen carrying capacity in the blood.

(3) *Health protection goals of the standard.* Prevention of adverse health effects for most workers from exposure to lead throughout a working lifetime requires that worker blood lead (PbB) levels be maintained at or below forty micrograms per one hundred grams of whole blood (40 µg/100g). The blood lead levels of workers (both male and female workers) who intend to have children should be maintained below 30 µg/100g to minimize adverse reproductive health effects in the parents and to the developing fetus.

The measurement of your blood lead level is the most useful indicator of the amount of lead being absorbed by your body. Blood lead levels (PbB) are most often reported in units of miligrams (mg) or micrograms (µg) of lead (1 mg = 1000 µg) per 100 grams (100g), 100 milliters (100 ml) or deciliter (dl) of blood. These three units are essentially the same. Sometimes PbB's are expressed in the form of mg% or µg%. This is a shorthand notation for 100g, 100ml, or dl.

PbB measurements show the amount of lead circulating in your blood stream, but do not give any information about the amount of lead stored in your various tissues. PbB measurements merely show current absorption of lead, not the effect that lead is having on your body or the effects that past lead exposure may have already caused. Past research into lead-related diseases, however, has focused heavily on associations between PbBs and various diseases. As a result, your PbB is an important indicator of the likelihood that you will gradually acquire a lead-related health impairment or disease.

Once your blood lead level climbs above 40 µg/100g, your risk of disease increases. There is a wide variability of individual response to lead, thus it is difficult to say that a particular PbB in a given person will cause a particular effect. Studies have associated fatal encephalopathy with PbBs as low as 150 µg/100g. Other studies have shown other forms of disease in some workers with PbBs well below 80µg/100g. Your PbB is a crucial indicator of the risks to your health, but one other factor is also extremely important. This factor is the length of time you have had elevated PbBs. The longer you have an elevated PbB, the greater the risk that large quantities of lead are being gradually stored in your organs and tissues (body burden). The greater your overall body burden, the greater the chances of substantial permanent damage.

The best way to prevent all forms of lead-related impairments and diseases — both short term and long term — is to maintain your PbB below 40µg/100g. The provisions of the standard are designed with this end in mind. Your employer has prime responsibility to assure that the provisions of the standard are complied with both by the company and by individual workers. You as a worker, however, also have a responsibility to assist your employer in complying with the standard. You can play a key role in protecting your own health by learning about the lead hazards and their control, learning what the standard requires, following the standard where it governs your own actions, and seeing that your employer complies with provisions governing his actions.

(4) *Reporting signs and symptoms of health problems.* You should immediately notify your employer if you develop signs or symptoms associated with lead poisoning or if you desire medical advice concerning the effects of current or past exposure to lead on your ability to have a health child. You should also notify your employer if you have difficulty breathing during a respirator fit test or while wearing a respirator. In each of these cases your employer must make available to you appropriate medical examinations or consultations. These must be provided at no cost to you and at a reasonable time and place.

The standard contains a procedure whereby you can obtain a second opinion by a physician of your choice if the employer selected the initial physician.

APPENDIX B — EMPLOYEE STANDARD SUMMARY

This appendix summarizes key provisions of the standard that you as a worker should become familiar with.

I. Permissible Exposure Limit (PEL)—paragraph (c)

The standards sets a permissible exposure limit (PEL) of fifty micrograms of lead per cubic meter of air (50 $\mu g/m^3$), averaged over an 8-hour work-day. This is the highest level of lead in air to which you may be permissably exposed over an 8-hour workday. Since it is an 8-hour average it permits short exposures above the PEL so long as for each 8-hour work day your average exposure does not exceed the PEL.

This standard recognizes that your daily exposure to lead can extend beyond a typical 8-hour workday as the result of overtime or other alterations in your work schedule. To deal with this, the standard contains a formula which reduces your permissible exposure when you are exposed more than 8 hours. For example, if you are exposed to lead for 10 hours a day, the maximum permitted average exposure would be 40 $\mu g/m^3$.

II. Exposure Monitoring—paragraph (d)

If lead is present in the workplace where you work in any quantity, your employer is required to make an initial determination of whether the action level is exceeded for any employee. This initial determination must include instrument monitoring of the air for the presence of lead and must cover the exposure of a representative number of employees who are reasonably believed to have the highest exposure levels. If your employer has conducted appropriate air sampling for lead in the past year he may use these results. If there have been any employee complaints of symptoms which may be attributable to exposure to lead or if there is any other information or observations which would indicate employee exposure to lead, this must also be considered as part of the initial determination. This initial determination must have been completed by March 31, 1979. If this initial determination shows that a reasonable possibility exists that *any* employee may be exposed, without regard to respirators, over the action level (30 $\mu g/m^3$) your employer must set up an air monitoring program to determine the exposure level of every employee exposed to lead at your workplace.

In carrying out this air monitoring program, your employer is not required to monitor the exposure of every employee, but he must monitor a representative number of employees and job types. Enough sampling must be done to enable each employee's exposure level to be reasonably represented by at least one full shift (at least 7 hours) air sample. In addition, these air samples must be taken under conditions which represent each employee's *regular*, daily exposure to lead. All initial exposure monitoring must have been completed by May 30, 1979.

If you are exposed to lead and air sampling is performed, your employer is required to quickly notify you in writing of air monitoring results which represent your exposure. If the results indicate your exposure exceeds the PEL (without regard to your use of respirators), then your employer must also notify you of this in writing, and provide you with a description of the corrective action that will be taken to reduce your exposure.

Your exposure must be rechecked by monitoring every six months if your exposuure is over the action level but below the PEL. Air monitoring must be repeated every three months if you are exposed over the PEL. Your employer may discontinue monitoring for you if 2 consecutive measurements, taken at least two weeks apart, are below the action level. However, whenever there is a production, process, control, or personnel change at your workplace which may result in new or additional exposure to lead, or whenever there is any other reason to suspect a change which may result in new or additional exposure to lead, your employer must perform additional monitoring.

III. Methods of Compliance—paragraph (e)

Your employer is required to assure that no employee is exposed to lead in excess of the PEL. The standard establishes a priority of methods to be used to meet the PEL.

IV. Respirator Protection—paragraph (f)

Your employer is required to provide and assure your use of respirators when your exposure to lead is not controlled below the PEL by other means. The employer must pay the cost of the respirator. Whenever you request one, your employer is also required to provide a respirator even if your air exposure level does not exceed the PEL. You might desire a respirator when, for example, you have received medical advice that your lead absorption should be decreased. Or, you may intend to have children in the near future, and want to reduce the level of lead in your body to minimize adverse reproductive effects. While respirators are the least satisfactory means of controlling your exposure, they are capable of providing significant protection if properly chosen, fitted, worn, cleaned, maintained, and replaced when they stop providing adequate protection.

Your employer is required to select respirators from the seven types listed in Table II of the Respiratory Protection section of the standard. Any respirator chosen must be approved by the Mine Safety and Health Administration (MSHA) or the National Institute for Occupational Safety and Health (NIOSH). This respirator selection table will enable your employer to choose a type of respirator which will give you a proper amount of protection based on your airborne lead exposure. Your employer may select a type of respirator that provides greater protection than that required by the standard; that is, one recommended for a higher concentration of lead than is present in your workplace. For example, a powdered air purifying respirator (PAPR) is much more protective than a typical negative pressure respirator, and may be also more comfortable to wear. A PAPR has a filter, cartridge or canister to clean the air, and a power source which continuously blows filtered air into your breathing zone. Your employer might make a PAPR available to you to ease the burden if having to wear a respirator for long periods of time. The standard provides that you can obtain a PAPR upon request.

Your employer must also start a Respiratory Protection Program. This program must include written procedures for the proper selection, use, cleaning, storage, and maintenance of respirators

Your employer must assure that your respirator facepiece fits properly. Proper fit of a respirator facepiece is critical. Obtaining a proper fit on each employee may require your employer to make available two or three different mask types. In order to assure that your respirator fits properly and that facepiece leakage is minimized, beginning on November 12, 1982, your employer must give you either a qualitative fit test in accordance with Appendix D of the standard, or a

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quantitative fit test if you use a negative pressure respirator. Any respirator which has a filter, cartridge, or canister which cleans the work room air before you breathe it and which requires the force of your inhalation to draw air through the filtering element is a negative pressure respirator. A positive pressure respirator supplies air to you directly. A quantitative fit test uses a sophisticated machine to measure the amount, if any, of test material that leaks into the facepiece of your respirator.

You must also receive from your employer proper training in the use of respirators. Your employer is required to teach you how to wear a respirator, to know why it is needed, and to understand its limitations.

Until March 1, 1980, your employer must test the effectiveness of your negative pressure respirator initially and at least every six months thereafter with a "qualitative fit test." In this test, the fit of the facepiece is checked by seeing if you can smell a substance placed outside the respirator. If you can, there is appreciable leakage where the facepiece meets your face.

The standard provides that if your respirator uses filter elements, you must be given an opportunity to change the filter elements whenever an increase in breathing resistance is detected. You also must be permitted to periodically leave your work area to wash your face and respirator facepiece whenever necessary to prevent skin irritation. If you ever have difficulty in breathing during a fit test or while using a respirator, your employer must make a medical examination available to you to determine whether you can safely wear a respirator. The result of this examination may be to give you a positive pressure respirator (which reduces breathing resistance) or to provide alternative means of protection.

V. Protective Work Clothing and Equipment—paragraph (g)

If you are exposed to lead above the PEL, or if you are exposed to lead compounds such as lead arsenate or lead azide which can cause skin and eye irritation, your employer must provide you with protective work clothing and equipment appropriate for the hazard. If work clothing is provided, it must be provided in a clean and dry condition at least weekly, and daily if your airborne exposure to lead is greater than 200 $\mu g/m^3$. Appropriate protective work clothing and equipment can include coveralls or similar full-body work clothing, gloves, hats, shoes or disposable shoe coverlets, and face shields or vented goggles. Your employer is required to provide all such equipment at no cost to you. He is responsible for providing repairs and replacement as necessary, and also is responsible for the cleaning, laundering or disposal of protective clothing and equipment. Contaminated work clothing or equipment must be removed in change rooms and not worn home or you will extend your exposure and expose your family since lead from your clothing can accumulate in your house, car, etc. Contaminated clothing which is to be cleaned, laundered or disposed of must be placed in closed containers in the change room. At no time may lead be removed from protective clothing or equipment by any means which disperses into the workroom air.

VI. Housekeeping—paragraph (h)

Your employer must establish a housekeeping program sufficient to maintain all surfaces as free as practicable of accumulations of lead dust. Vacuuming is the preferred method of meeting this requirement, and the use of compressed air to clean floors and other surfaces is absolutely prohibited. Dry or wet sweeping, shoveling, or brushing may not be used except where vacuuming or other equally effective methods have been tried and do not work. Vacuums must be used and emptied in a manner which minimizes the reentry of lead into the workplace.

VII. Hygiene Facilities and Practices—paragraph (i)

The standard requires that change rooms, showers, and filtered air lunchrooms be constructed and made available to workers exposed to lead above the PEL. When the PEL is exceeded and these facilities are available, however, the employer must assure that food and beverage is not present or consumed, tobacco products are not present or used, and cosmetics are not applied, except in these facilities. Change rooms, showers, and lunchrooms, if available, must be used by workers exposed in excess of the PEL. After showering, *no* clothing or equipment worn during the shift may be worn home, and this includes shoes and underwear. Your own clothing worn during the shift should be carried home and cleaned carefully so that it does not contaminate your home. Lunchrooms may not be entered with protective clothing or equipment unless surface dust has been removed by vacuuming, downdraft booth, or other cleaning method. Finally, workers exposed above the PEL must wash both their hands and faces prior to eating, drinking, smoking or applying cosmetics.

All of the facilities and hygiene practices just discussed are essential to minimize additional sources of lead absorption from inhalation or ingestion of lead that may accumulate on you, your clothes, or your possessions. Strict compliance with these provisions can virtually eliminate several sources of lead exposure which significantly contribute to excessive lead absorption.

VIII. Medical Surveillance—paragraph (j)

The medical surveillance program is part of the standard's comprehensive approach to the prevention of lead-related disease. Its purpose is to supplement the main thrust of the standard which is aimed at minimizing airborne concentrations of lead and sources of ingestion. Only medical surveillance can determine if the other provisions of the standard have affectively protected you as an individual. Compliance with the standard's provision will protect most workers from the adverse effects of lead exposure, but may not be satisfactory to protect individual workers (1) who have high body burdens of lead acquired over past years, (2) who have additional, uncontrolled sources of non-occupational lead exposure, (3) who exhibit unusual variations in lead absorption rates, or (4) who have specific non-work related medical conditions which could be aggravated by lead exposure (e.g., renal disease, anemia). In addition, control systems may fail, or hygeine and respirator programs may be inadequate. Periodic medical surveillance of individual workers will help detect those failures. Medical surveillance will also be important to protect your reproductive ability—regardless of whether you are a man or woman.

All medical surveillance required by the standards must be performed by or under the supervision of a licensed physician. The employer must provide required medical surveillance without cost to employees and at a reasonable time and place. The standard's medical surveillance program has two parts—periodic biological monitoring and medical examinations.

Your employer's obligation to offer you medical surveillance is triggered

by the results of the air monitoring program. Medical surveillance must be made available to all employees who are exposed in excess of the action level for more than 30 days a year. The initial phase of the medical surveillance program, which includes blood lead level tests and medical examinations, must be completed for all covered employees no later than August 28, 1979. Priority within this first round of medical surveillance must be given to employees whom the employer believes to be at greatest risk from continued exposure (for example, those with the longest prior exposure to lead, or those with the highest current exposure). Thereafter, the employer must periodically make medical surveillance—both biological monitoring and medical examinations—available to all covered employees.

Biological monitoring under the standard consists of blood lead level (PbB) and zinc protoporphyrin tests at least every 6 months after the initial PbB test. A zinc protoporphyrin (ZPP) test is a very useful blood test which measures an effect of lead on your body. Thus biological monitoring under the standard is currently limited to PbB testing. If a worker's PbB exceeds 40 μg/100g the monitoring frequency must be increased from every 6 months to at least every 2 months and not reduced until two consecutive PbBs indicate a blood level below 40 μg/100g. Each time your PbB is determined to be over 40 μg/100g, your employer must notify you of this in writing within five working days of his receipt of the test results. The employer must also inform you that the standard requires temporary medical removal with economic protection when your PbB exceeds certain criteria (See Discussion of Medical Removal Protection—Paragraph (k)). During the first year of the standard, this removal criterion is 80 μg/100g. Anytime your PbB exceeds 80 μg/100g your employer must make available to you a prompt follow-up PbB test to ascertain your PbB. If the two tests both exceed 80 μg/100g and you are temporarily removed, then your employer must make successive PbB tests available to you on a monthly basis during the period of your removal.

Medical examinations beyond the initial one must be made available on an annual basis if your blood level exceeds 40 μg/100g at any time during the preceeding year. The initial examination will provide information to establish a baseline to which subsequent data can be compared. An initial medical examination must also be made available (prior to assignment) for each employee being assigned for the first time to an area where the airborne concentration of lead equals or exceeds the action level. In addition, a medical examination or consultation must be made available as soon as possible if you notify your employer that you are experiencing signs or symptoms commonly associated with lead poisoning or that you have difficulty breathing while wearing a respirator or during a respirator fit test. You must also be provided a medical examination or consultation if you notify your employer that you desire medical advice concerning the effects of current or past exposure to lead on your ability to procreate a healthy child.

Finally, appropriate follow-up medical examinations or consultations may also be provided for employees who have been temporarily removed from exposure under the medical removal protection provisions of the standard (See Part IX, below).

The standard specifies the minimum content of pre-assignment and annual medical examinations. The content of other types of medical examinations and consultations is left up to the sound discretion of the examining physician. Pre-assignment and annual medical examinations must include (1) a detailed work history and medical history, (2) a thorough physical examination, and (3) a series of laboratory tests designed to check your blood chemistry and your kidney function. In addition, at any time upon your request, a laboratory evaluation of male fertility will be made (microscopic examination of a sperm sample), or a pregnancy test will be given.

The standard does not require that you participate in any of the medical procedures, tests, etc. which your employer is required to make available to you. Medical surveillance can, however, play a very important role in protecting your health. You are strongly encouraged, therefore, to participate in a meaningful fashion. The standard contains a mutiple physician review mechanism which would give you a chance to have a physician of your choice directly participate in the medical surveillance program. If you were dissatisfied with an examination by a physician chosen by your employer, you could select a second physician to conduct an independent analysis. The two doctors would attempt to resolve any differences of opinion, and select a third physician to resolve any firm dispute. Generally, your employer will choose the physician who conducts medical surveillance under the lead standard—unless you and your employer can agree on the choice of a physician or physicians. Some companies and unions have agreed in advance, for example, to use certain independent medical laboratories or panels of physicians. Any of these arrangements are acceptable so long as required medical surveillance is made available to workers.

The standard requires your employer to provide certain information to a physician to aid in his or her examination of you. This information includes (1) the standard and its appendices, (2) a description of your duties as they relate to lead exposure, (3) your exposure level, (4) a description of personal protective equipment you wear, (5) prior blood lead level results, and (6) prior written medical opinions concerning you that the employer has. After a medical examination or consultation the physician must prepare a written report which must contain (1) the physician's opinion as to whether you have any medical condition which places you at increased risk of material impairment to health from exposure to lead, (2) any recommended special protective measures to be provided to you, (3) any blood lead level determination, and (4) any recommended limitation on your use of respirators. This last element must include a determination of whether you can wear a powered air purifying respirator (PAPR) if you are found unable to wear a negative pressure respirator.

The medical surveillance program of the lead standard may at some point in time serve to notify certain workers that they have acquired a disease or other adverse medical condition as a result of occupational lead exposure. If this is true, these workers might have legal rights to compensation from public agencies, their employers, firms that supply hazardous products to their employers, or other persons. Some states have laws, including worker compensation laws, that disallow a worker who learns of a job-related health impairment to sue, unless the worker sues within a short period of time after learning of the impairment. (This period of time may be a matter of months or years.) An attorney can be consulted about these possibilities. It should be stressed that OSHA is in

no way trying to either encourage or discourage claims or lawsuits. However, since results of the standard's medical surveillance program can significantly affect the legal remedies of a worker who has acquired a job-related disease or impairment, it is proper for OSHA to make you aware of this.

The medical surveillance section of the standard also contains provisions dealing with chelation. Chelation is the use of certain drugs (administered in pill form or injected into the body) to reduce the amount of lead absorbed in body tissues. Experience accumulated by the medical and scientific communities has largely confirmed the effectiveness of this type of therapy for the treatment of very severe lead poisoning. On the other hand, it has also been established that there can be a long list of extremely harmful side effects associated with the use of chelating agents in various circumstances and has established when the use of these agents is acceptable. The standard includes these accepted imitations due to a history of abuse of chelation therapy by some lead companies. The most widely use chelating agents are calcium disodium EDTA, (Ca NA_2 EDTA), Calcium Disodium Versenate (Versenate), and d-penicillamine (pencillamine or Cupramine).

The standard prohibits "prophylactic chelation" of any employee by any person the employer retains, supervises or controls. "Prophylactic chelation" is the routine use of chelating or similarly acting drugs to *prevent* elevated blood levels in workers who are occupationally exposed to lead, or the use of these drugs to *routinely* lower blood lead levels to predesignated concentrations believed to be 'safe'. It should be emphasized that where an employer takes a worker who has no symptoms of lead poisoning and has chelation carried out by a physician (either inside or outside of a hospital) solely to reduce the worker's blood lead level, that will generally be considered prophylactic chelation. The use of a hospital and a physician does not mean that prophylactic chelation is not being performed. Routine chelation to prevent increased or reduce current blood lead levels is unacceptable whatever the setting.

The standard allows the use of "therapeutic" or "diagnostic" chelation if administered under the supervision of a licensed physician in a clinical setting with thorough and appropriate medical monitoring. Therapeutic chelation responds to severe lead poisoning where there are marked symptoms. Diagnostic chelation involves giving a patient a dose of the drug then collecting all urine excreted for some period of time as an aid to the diagnosis of lead poisoning.

In cases where the examining physician determines that chelation is appropriate, you must be notified in writing of this fact before such treatment. This will inform you of a potentially harmful treatment, and allow you to obtain a second opinion.

IX. Medical Removal Protection Paragraph (k)

Excessive lead absorption subjects you to increased risk of disease. Medical removal protection (MRP) is a means of protecting you when, for whatever reasons, other methods, such as engineering controls, work practices, and respirators, have failed to provide the protection you need. MRP involves the temporary removal of a worker from his or her regular job to a place of significantly lower exposure without any loss of earnings, seniority, or other employment rights or benefits. The purpose of this program is to cease further lead absorption and allow your body to naturally excrete lead which has previously been absorbed. Temporary medical removal can result from an elevated blood lead level, or a medical opinion. Up to eighteen months of protection is provided as a result of either form of removal. The vast majority of removed workers, however, will return to their former jobs long before this eigthteen month period expires. The standard contains special provisions to deal with the extraordinary but possible case where a longterm worker's blood lead level does not adequately decline during eighteen months of removal.

During the first year of the standard, if your blood lead level is 80 μg/100g or above you must be removed from any exposure where your air lead level without a respirator would be 100 μg/m³ or above. If you are removed from your normal job you may not be returned until your blood lead level declines to at least 60 μg/100g. These criteria for removal and return will change according to the following schedule:

	Removal blood lead (μg/100g)	Air lead (μg/m³)	Return to blood lead (μg/100 g)
After Mar. 1, 1980 ..	70 and above	50 and above	At or below 50.
After Mar. 1, 1981 ..	60 and above	30 and above	At or below 40.
After Mar. 1, 1983 ..	50 and above averaged over six months.	30 and above	At or below 40.

You may also be removed from exposure even if your blood lead levels are below these criteria if a final medical determination indicates that you temporarily need reduced lead exposure for medical reasons. If the physician who is implementing your employers medical program makes a final written opinion recommending your removal or other special protective measures, your employer must implement the physician's recommendation. If you are removed in this manner, you may only be returned when the doctor indicates that it is safe for you to do so.

The standard does not give specific instructions dealing with what an employer must do with a removed worker. Your job assignment upon removal is a matter for you, your employer and your union (if any) to work out consistent with existing procedures for job assignments. Each removal must be accomplished in a manner consistent with existing collective bargaining relationships. Your employer is given broad discretion to implement temporary removals so long as no attempt is made to override existing agreements. Similarly, a removed worker is provided no right to veto an employer's choice which satisfies the standards.

In most cases, employers will likely transfer removed employees to other jobs with sufficiently low lead exposure. Alternatively, a worker's hours may be reduced so that the time weighted average exposure is reduced, or he or she may be temporarily laid off if no other alternative is feasible.

In all of these situations, MRP benefits must be provided during the period of removal—i.e., you continue to receive the same earnings, seniority, and other rights and benefits you would have had if you had not been removed. Earnings include more than just your base wage; it includes overtime, shift differentials, incentives, and other compensation you would have earned if you had not been removed. During the period of removal you must also be provided with appropriate follow-up medical

surveillance. If you were removed because your blood lead level was too high, you must be provided with a monthly blood test. If a medical opinion caused your removal, you must be provided medical tests or examinations that the doctor believes to be appropriate. If you do not participate in this follow up medical surveillance, you may lose your eligibility for MRP benefits.

When you are medically eligible to return to your former job, your employer must return you to your "former job status." This means that you are entitled to the position, wages, benefits, etc., you would have had if you had not been removed. If you would still be in your old job if no removal had occurred that is where you go back. If not, you are returned consistent with whatever job assignment discretion your employer would have had if no removal had occurred. MRP only seeks to maintain your rights, not expand them or diminish them.

If you are removed under MRP and you are also eligible for worker compensation or other compensation for lost wages, your employer's MRP benefits obligation is reduced by the amount that you *actually* receive from these other sources. This is also true if you obtain other employment during the time you are laid off with MRP benefits.

The standard also covers situations where an employer *voluntarily* removes a worker from exposure to lead due to the effects of lead on the employee's medical condition, even though the standard does not require removal. In these situations MRP benefits must still be provided as though the standard required removal. Finally, it is important to note that in all cases where removal is required, respirators cannot be used as a substitute. Respirators may be used before removal becomes necessary, but not as an alternative to a transfer to a low exposure job, or to a lay-off with MRP benefits.

X. Employee Information and Training—Paragraph (l)

Your employer is required to provide an information and training program for all employees exposed to lead above the action level or who may suffer skin or eye irritation from lead. This program must inform these employees of the specific hazards associated with their work environment, protective measures which can be taken, the danger of lead to their bodies (including their reproductive systems), and their rights under the standard. In addition your employer must make readily available to all employees, including those exposed below the action level, a copy of the standard and its appendices and must distribute to all employees any materials provided to the employer by the Occupational Safety and Health Administration (OSHA).

Your employer is required to complete this training program for all employees by August 28, 1979. After this date, all new employees must be trained prior to initial assignment to areas where there is a possibility of exposure over the action level.

This training program must also be provided at least annually thereafter.

XI. Signs—Paragraph (m)

The standard requires that the following warning sign be posted in work areas where the exposure to lead exceeds the PEL:

WARNING

LEAD WORK AREA

NO SMOKING OR EATING

XI. Recordkeeping—Paragraph (n)

Your employer is required to keep all records of exposure monitoring for airborne lead. These records must include the name and job classification of employees measured, details of the sampling and analytic techniques, the results of this sampling, and the type of respiratory protection being worn by the person sampled. Your employer is also required to keep all records of biological monitoring and medical examination results. These must include the names of the employees, the physician's written opinion, and copy of the results of the examination. All of the above kinds of records must be kept for 40 years, or for at least 20 years after your termination of employment, whichever is longer.

Recordkeeping is also required if you are temporarily removed from your job under the medical removal protection program. This record must include your name and social security number, the date of your removal and return, how the removal was or is being accomplished, and whether or not the reason for the removal was an elevated blood lead level. Your employer is required to keep each medical removal record only for as long as the duration of an employee's employment.

The standard requires that if you request to see or copy environmental monitoring, blood lead level monitoring, or medical removal records, they must be made available to you or to a representative that you authorize. Your union also has access to these records. Medical records other than PbB's must also be provided upon request to you, to your physician or to any other person whom you may specifically designate. Your union does not have access to your personnel medical records unless you authorize their access.

XIII. Observations of Monitoring—Paragraph (o)

When air monitoring for lead is performed at your workplace as required by this standard, your employer must allow you or someone you designate to act as an observer of the monitoring. Observers are entitled to an explanation of the measurement procedure, and to record the results obtained. Since results will not normally be available at the time of the monitoring, observers are entitled to record or receive the results of the monitoring when returned by the laboratory. Your employer is required to provide the observer with any personal protective devices required to be worn by employees working in the area that is being monitored. The employer must require the observer to wear all such equipment and to comply with all other applicable safety and health procedures.

XIV. Effective Date—Paragraph (p)

The standard's effective date is March 1, 1979, and employer obligations under the standard begin to come into effect as of that date.

XV. For Additional Information

A. Copies of the Standard and explanatory materials can be obtained free of charge by calling or writing the OSHA Office of Publications, Room S-1212, United States Department of Labor, Washington, D.C. 20210: Telephone (202) 523-6138. The following pucblications are available:

1. The standard and summary of the statement of reasons (preamble), Federal Register, Volume 43, pp. 52952-53014, November 14, 1978.
2. The full statement of reasons (preamble) Federal Register, vol. 43, pp. 54354-54509, November 21, 1978.
3. Partial Administrative Stay and Corrections to the standard, (44 FR 5446-5448) January 26, 1979.
4. Notice of the Partial Judicial Stay (44 FR 14554-14555) March 13, 1979.
5. Corrections to the preamble, Federal Register, vol. 44, pp. 20680-20681, April 6, 1979.
6. Additional correction to the preamble concerning the construction

industry, Federal Register, vol. 44, p. 50338, August 28, 1979.

7. Appendices to the standard (Appendices A,B,C), Federal Register, Vol. 44, pp. 60980-60995, October 23, 1979.

8. Corrections to appendices, Federal Register, Vol. 44, 68828, November 30, 1979.

9. Revision to the standard and additional appendices (appendices D and E), Federal Register, Vol. 47, pp. 51117-51119, November 12, 1982.

B. Additional information about the standard, its enforcement, and your employer's compliance can be obtained from the nearest OSHA Area Office listed in your telephone directory under United States Government/Department of Labor.

Introduction

The primary purpose of the Occupational Safety and Health Act of 1970 is to assure, so far as possible, safe and healthful working conditions for every working man and woman. The occupational health standard for inorganic lead was promulgated to protect workers exposed to inorganic lead including metallic lead, all inorganic lead compounds and organic lead soaps.

Under this final standard in effect as of March 1, 1979, occupational exposure to inorganic lead is to be limited to 50 μg/m³ (micrograms per cubic meter) based on an 8 hour time-weighted average (TWA). This level of exposure eventually must be achieved through a combination of engineering, work practice and other administrative controls. Periods of time ranging from 1 to 10 years are provided for different industries to implement these controls. The schedule which is based on individual industry considerations is given in Table 1. Until these controls are in place, respirators must be used to meet the 50 μg/m³ exposure limit.

The standard also provides for a program of biological monitoring and medical surveillance for all employees exposed to levels of inorganic lead above the action level of 30 μg/m³ (TWA) for more than 30 days per year.

The purpose of this document is to outline the medical surveillance provisions of the standard for inorganic lead, and to provide further information to the physician regarding the examination and evaluation of workers exposed to inorganic lead.

Section 1 provides a detailed description of the monitoring procedure including the required frequency of blood testing for exposed workers, provision for medical removal protection (MRP), the recommended right of the employee to a second medical opinion, and notification and protection (MRP), the recommended right of the employee to a second medical opinion, and notification and recordkeeping requirements of the employer. A discussion of the requirements for respirator use and respirator monitoring and OSHA's position on prophylactic chelation therapy are also included in this section.

Section 2 discusses the toxic effects and clinical manifestations of lead poisoning and effects of lead intoxication on enzymatic pathways in heme synthesis. The adverse effects on both male and female reproductive capacity and on the fetus are also discussed.

Section 3 outlines the recommended medical evaluation of the worker exposed to inorganic lead including details of the medical history, physical examination, and recommended laboratory tests, which are based on the toxic effects of lead as discussed in Section 2.

Section 4 provides detailed information concerning the laboratory tests available for the monitoring of exposed workers. Included also is a discussion of the relative value of each test and the limitations and precautions which are necessary in the interpretation of the laboratory results.

I. Medical surveillance and monitoring requirements for workers exposed to inorganic lead

Under the occupational health standard for inorganic lead, a program of biological monitoring and medical surveillance is to be made available to all employees exposed to lead above the action level of 30 μg/m³ TWA for more tham 30 days each year. This program consists of periodic blood sampling and medical evaluation to be performed on a schedule which is defined by previous laboratory results, worker complaints or concerns, and the clinical assessment of the examining physician.

Under this program, the blood lead level of all employees who are exposed to lead above the action level of 30 μg/m³ is to be determined at least every six months. The frequency is increased to every two months for employees whose last blood lead level was between 40 μg/100 g whole blood and the level requiring employee medical removal to be discussed below. For employees who are removed from exposure to lead due to an elevated blood lead, a new blood lead level must be measured monthly. A zinc protoporphyrin (ZPP) measurement is strongly recommended on each occasion that a blood lead level measurement is made.

An annual medical examination and consultation performed under the guidelines discussed in Section 3 is to be made available to each employee for whom a blood test conducted at any time during the preceding 12 months indicated a blood lead level at or above 40 μg/100 g. Also, an examination is to be given to all employees prior to their assignment to an area in which airborne lead concentrations reach or exceed the action level. In addition, a medical examination must be provided as soon as possible after notification by an employee that the employee has developed signs or symptoms commonly associated with lead intoxication, that the employee desires medical advice regarding lead exposure and the ability to procreate a healthy child, or that the employee has demonstrated difficulty in breathing during a respirator fitting test or during respirator use. An examination is also to be made available to each employee removed from exposure to lead due to a risk of sustaining material impairment to health, or otherwise limited or specially protected pursuant to medical recommendations.

Results of biological monitoring or the recommendation of an examing physician may necessitate removal of an employee from further lead exposure pursuant to the standard's medical removal protection (MRP) program. The object of the MRP program is to provide temporary medical removal to workers either with substantially elevated blood lead levels or otherwise at risk of sustaining material health impairment from continued substantial exposure to lead. The following guidelines which are summarized in Table 2 were created under the standard for the temporary removal of an exposed employee and his or her subsequent return to work in an exposure area.

Table 1

Permissible airborne lead levels by industry (μg/m³)*	Effective date					
	Mar. 1, 1979	Mar. 1, 1980	Mar. 1, 1981	Mar. 1, 1982	Mar. 1, 1984	Mar. 1, 1989 (final)
1. Primary lead production	200	200	200	100	100	50
2. Secondary lead production	200	200	200	100	50	50
3. Lead-acid battery manufacturing	200	200	100	100	50	50
4. Nonferrous foundries	200	100	100	100	50	50
5. Lead pigment manufacturing	200	200	200	100	50	50
6. All other industries	200	50	50	50	50	50

*Airborne levels to be achieved without reliance or respirator protection through a combination of engineering, work practice and other administrative controls. While these controls are being implemented respirators must be used to meet the 50 μg/m³ exposure limit.

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Table 2

	Effective date				
	Mar. 1, 1979	Mar. 1, 1980	Mar. 1, 1981	Mar. 1, 1982	Mar., 1983 (final)
A. Blood lead level requiring employee medical removal (Level must be confirmed with second follow-up blood lead level within two weeks of first report).	≥80 μg/100 g..	≥70 μg/100 g..	≥60 μg/100 g..	≥60 μg/100 g..	≥60μg/100 g or average of last three blood samples or all blood samples over previous 6 months (whichever is over a longer time period) is 50 μg/100 g or greater unless last blood sample is 40 μg/100 g or less.
B. Frequency which employees exposed to action level of lead (30 μg/m³ TWA) must have blood lead level checked (ZPP is also strongly recommended in each occasion that a blood lead is obtained):					
1. Last blood lead level less than 40 μg/100 g	Every 6 months.	Every 6 months.	Every 6 months.	Every 6 months.	Every 6 months.
2. Last blood lead level between 40 μg/100 g and level requiring medical removal (see A above).	Every 2 months.	Every 2 months.	Every 2 months.	Every 2 months.	Every 2 months.
3. Employees removed from exposure to lead because of an elevated blood lead level.	Every 1 month.	Every 1 month.	Every 1 month.	Every 1 month.	Every 1 month.
C. Permissible airborne exposure limit for workers removed from work due to an elevated blood lead level (without regard to respirator protection).	100 μg/m³ 8 hr TWA.	50 μg/m³ 8 hr TWA.	30 μg/m³ 8 hr TWA.	30 μg/m³ 8 hr TWA.	30 μg/m³ 8 hr TWA.
D. Blood lead level confirmed with a second blood analysis, at which employee may return to work. Permissible exposure without regard to respirator protection is listed by industry in Table 1.	<60 μg/100 g...	<50 μg/100 g...	<40 μg/100 g...	<40 μg/100 g...	<40 μg/100 g...

NOTE: —When medical opinion indicates that an employee is at risk of material impairment from exposure to lead; the physician can remove an employee from exposures exceeding the action level (or less) or recommend special protective measures as deemed appropriate and necessary. Medical monitoring during the medical removal period can be more stringent than noted in the table above if the physician so specifies. Return to work or removal of limitations and special protections is permitted when the physician indicates that the worker is no longer at risk of material impairment.

Under the standard's ultimate worker removal criteria, a worker is to be removed from any work having any eight hour TWA exposure to lead of 30 μg/m³ or more whenever either of the following circumstances apply: (1) a blood lead level of 60 μg/100 g or greater is obtained and confirmed by a second follow-up blood lead level performed within two weeks after the employer receives the results of the first blood sampling test, or (2) the average of the previous three blood lead determinations or the average of all blood lead determinations conducted during the previous six months, whichever encompasses the longest time period, equals or exceeds 50 μg/100 g, unless the last blood sample indicates a blood lead level at or below 40 μg/100 g in which case the employee need not be removed. Medical removal is to continue until two consecutive blood lead levels are 40 μg/100 g or less.

During the first two years that the ultimate removal criteria are being phased in, the return criteria have been set to assure that a worker's blood lead level has substanitially declined during the period of removal. From March 1, 1979 to March 1, 1980, the blood lead level requiring employee medical removal is 80 μg/100 g. Workers found to have a confirmed blood lead at this level or greater need only to be removed from work having a daily 8 hour TWA exposure to lead at or above 100 μg/m³. Workers so removed are to be returned to work when their blood lead levels are at or below 60 μg/100 g of whole blood. From March 1, 1980 to March 1, 1981, the blood lead level requiring medical removal is 70 μg/100 g. During this period workers need only be removed from jobs having a daily 8 hour TWA exposure to lead at or above 50 μg/m³ and are to be returned to work when a level of 50 μg/100 g is achieved. Beginning March 1, 1981, return depends on a worker's blood lead level declining to 40 μg/100 g of whole blood.

As part of the standard, the employer is required to notify in writing each employee whose blood lead level exceeds 40 μg/100 g. In addition each such employee is to be informed that the standard requires medical removal with MRP benefits, discussed below, when an employee's blood lead level exceeds the above defined limits.

In addition to the above blood lead level criteria, temporary worker removal may also take place as a result of medical determinations and recommendations. Written medical opinions must be prepared after each examination pursuant to the standard. If the examining physician includes a medical finding, determination or opinion that the employee has a medical condition which places the employee at increased risk of material health impairment from exposure to lead, then the employee must be removed from exposure to lead at or above the action level. Alternatively, if the examining physician recommends special protective measures for an employee (e.g., use of a powered air purifying respirator) or recommends limitations on an employee's exposure to lead, then the employer must implement these recommendations. Recommendations may be more stringent than the specific provisions of the standard. The examining physician, therefore, is given broad flexibility to tailor special protective procedures to the needs of individual employees. This flexibility extends to the evaluation and management of pregnant workers and male and female workers who are planning to raise children. Based on the history, physical examination, and laboratory studies, the physician might recommend special protective measures or medical removal for an employee who is pregnant or who is planning to conceive a child when, in the physician's judgment, continued exposure to lead at the current job would pose a significant risk. The return of the employee to his or her former job status, or the removal of special protections or limitations, depends upon the examining physician

determining that the employee is no longer at increased risk of material impairment or that special measures are no longer needed.

During the period of any form of special protection or removal, the employer must maintain the worker's earnings, seniority, and other employment rights and benefits (as though the worker had not been removed) for a period of up to 18 months. This economic protection will maximize meaningful worker participation in the medical surveillance program, and is appropriate as part of the employer's overall obligation to provide a safe and healthful workplace. The provisions of MRP benefits during the employee's removal period may, however, be conditioned upon participation in medical surveillance.

On rare occasions, an employee's blood lead level may not acceptably decline within 18 months of removal. This situation will arise only in unusual circumstances, thus the standard relies on an individual medical examination to determine how to protect such an employee. This medical determination is to be based on both laboratory values, including lead levels, zinc protoprophyrin levels, blood counts, and other tests felt to be warranted, as well as the physician's judgment that any symptoms or findings on physical examination are a result of lead toxicity. The medical determination may be that the employee is incapable of ever safely returning to his or her former job status. The medical determination may provide additional removal time past 18 months for some employees or specify special protective measures to be implemented.

The lead standard provides for a multiple physician review in cases where the employee wishes a second opinion concerning potential lead poisoning or toxicity. If an employee wishes a seond opinion, he or she can make an appointment with a physician of his or her choice. This second physician will review the findings, recommendations or determinations of the first physician and conduct any examinations, consultations or tests deemed necessary in an attempt to make a final medical determination. If the first and second physicians do not agree in their assessment they must try to resolve their differences. If they cannot reach an agreement then they must designate a third physician to resolve the dispute.

The employer must provide examining and consulting physicians with the following specific information: a copy of the lead regulations and all appendices, a description of the employee's duties as related to exposure, the exposure level to lead and any other toxic substances (if applicable), a description of personal protective equipment used, blood lead levels, and all prior written medical opinions regarding the employee in the employer's possession or control. The employer must also obtain from the physician and provide the employee with a written medical opinion containing blood lead levels, the physician's opinion as to whether the employee is at risk of material impairment to health, any recommended protective measures for the employee if further exposure is permitted, as well as any recommended limitations upon an employee's use of respirators.

Employers must instruct each physician not to reveal to the employer in writing or in any other way his or her findings, laboratory results, or diagnoses which are felt to be unrelated to occupational lead exposure. They must also instruct each physician to advise the employee of any occupationally or non-occupationally related medical conditions requiring further treatment or evaluation.

The standard provides for the use of respirators where engineering and other primary controls have not been fully implemented. However, the use of respirator protection shall not be used in lieu of temporary medical removal due to elevated blood lead levels or findings that an employee is at risk of material health impairment. This is based on the numerous inadequacies of respirators including skin rash where the facepiece makes contact with the skin, unacceptable stress to breathing in some workers with underlying cardiopulmonary impairment, difficulty in providing adequate fit, the tendency for respirators to create additional hazards by interfering with vision, hearing, and mobility, and the difficulties of assuring the maximum effectiveness of a complicated work practice program involving respirators. Respirators do, however, serve a useful function where engineering and work practice controls are inadequate by providing supplementary, interim, or short-term protection, provided they are properly selected for the environment in which the employee will be working, properly fitted to the employee, maintained and cleaned periodically, and worn by the employee when required.

In its final standard on occupational exposure to inorganic lead, OSHA has prohibited prophylactic chelation. Diagnostic and therapeutic chelation are permitted only under the supervision of a licensed physician with appropriate medical monitoring in an acceptable clinical setting. The decision to initiate chelation therapy must be made on an individual basis and take into account the severity of symptoms felt to be a result of lead toxicity along with blood lead levels, ZPP levels, and other laboratory tests as appropriate. EDTA and penicillamine which are the primary chelating agents use in the therapy of occupational lead poisoning have significant potential side effects and their use must be justified on the basis of expected benefits to the worker. Unless frank and severe symptoms are present, therapeutic chelation is not recommended given the opportunity to remove a worker from exposure and allow the body to naturally excrete accumulated lead. As a diagnostic aid, the chelation mobilization test using CA-EDTA has limited applicability. According to some investigators, the test can differentiate between lead-induced and other nephropathies. The test may also provide an estimation of the mobile fraction of the total body lead burden.

Employers are required to assure that accurate records are maintained on exposure monitoring, medical surveillance, medical removal for each employee. Exposure monitoring and medical surveillance records must be kept for 40 years for the duration of employment plus 20 years, whichever is longer, while medical removal records must be maintained for the duration of employment. All records required under the standard must be available upon request to the Assistant Secretary of Labor for Occupational Safety and Health and the Director for the National Institute for Occupational Safety and Health. Employers must also make environmental and biological monitoring and medical removal records available to affected employees and to former employees or their authorized employee representatives. Employees or their specifically designated representatives have access to their entire medical surveillance records.

In addition, the standard requires that the employer inform all workers exposed to lead at or above the action level of the provisions of the standard and all its appendices, the purpose and description of medical surveillance and provisions for medical removal protection if temporary removal is required. An understanding of the potential health effects of lead exposure by all exposed employees along with full understanding of their rights under the lead standard is essential for an effective monitoring program.

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II. Adverse health effects of inorganic lead

Although the toxicity of lead has been known for 2,000 years, the knowledge of the complex relationship between lead exposure and human response is still being refined. Significant research into the toxic properties of lead continues throughout the world, and it should be anticipated that our understanding of thresholds of effects and margins of safety will be improved in future years. The provisions of the lead standard are founded on two prime medical judgments: first, the prevention of adverse health effects from exposure to lead throughout a working lifetime requires that worker blood lead levels be maintained at or below 40 μg/100 g and second, the blood lead levels of workers, male or female, who intend to parent in the near future should be maintained below 30 μg/100 g to minimize adverse reproductive health effects to the parents and developing fetus. The adverse effects of lead on reproduction are being actively researched and OSHA encourages the physician to remain abreast of recent developments in the area to best advise pregnant workers or workers planning to conceive children.

The spectrum of health effects caused by lead exposure can be subdivided into five developmental stages: normal, physiological changes of uncertain significance, pathophysiological changes, overt symptoms (morbidity), and mortality. Within this process there are no sharp distinctions, but rather a continuum of effects. Boundaries between categories overlap due to the wide variation of individual responses and exposures in the working population. OSHA's development of the lead standard focused on pathophysiological changes as well as later stages of disease.

1. *Heme Synthesis Inhibition.* The earliest demonstrated effect of lead involves its ability to inhibit at least two enzymes of the heme synthesis pathway at very low blood levels. Inhibition of delta aminolevulinic acid dehydrase (ALA-D) which catalyzes the conversion of delta-aminolevulinic acid (ALA) to protoporphyrin is observed at a blood lead level below 20 μg/100 g whole blood. At a blood level of 40 μg/100 g, more than 20% of the population would have 70% inhibition of ALA-D. There is an exponential increase in ALA excretion at blood lead levels greater than 40 μg/100 g.

Another enzyme, ferrochelatase, is also inhibited at low blood lead levels. Inhibition of ferrochelatase leads to increased free erythrocyte protoporphyrin (FEP) in the blood which can then bind to zinc to yield zinc protoporphyrin. At a blood lead level of 50 μg/100 g or greater, nearly 100% of the population will have an increase in FEP. There is also an exponential relationship between blood lead levels greater than 40 μg/100 g and the associated ZPP level, which has led to the development of the ZPP screening test for lead exposure.

While the significance of these effects is subject to debate, it is OSHA's position that these enzyme disturbances are early stages of a disease process which may eventually result in the clinical symptoms of lead poisoning. Whether or not the effects do progress to the later stages of clinical disease, disruption of these enzyme processes over a working lifetime is considered to be a material impairment of health.

One of the eventual results of lead-induced inhibition of enzymes in the heme synthesis pathway is anemia which can be asymptomatic if mild but associated with a wide array of symptoms including dizziness, fatigue, and tachycardia when more severe. Studies have indicated that lead levels as low as 50 μg/100 g can be associated with a definite decreased hemoglobin, although most cases of lead-induced anemia, as well as shortened red-cell survival times, occur at lead levels exceeding 80 μg/100 g. Inhibited hemoglobin synthesis is more common in chronic cases whereas shortened erythocyte life span is more common in acute cases.

In lead-induced anemias, there is usually a reticulocytosis along with the presence of basophilic stippling, and ringed sideroblasts, although none of the above are pathognomonic for lead-induced anemia.

2. *Neurological Effects.* Inorganic lead has been found to have toxic effects on both the central and peripheral nervous systems. The earliest stages of lead-induced central nervous system effects first manifest themselves in the form of behavioral disturbances and central nervous system symptoms including irritability, restlessness, insomnia and other sleep disturbances, fatigue, vertigo, headache, poor memory, tremor, depression, and apathy. With more severe exposure, symptoms can progress to drowsiness, stupor, hallucinations, delerium, convulsions and coma.

The most severe and acute form of lead poisoning which usually follows ingestion or inhalation of large amounts of lead is acute encephalopathy which may arise precipitously with the onset of intractable seizures, coma, cardiorespiratory arrest, and death within 48 hours.

While there is disagreement about what exposure levels are needed to produce the earliest symptoms, most experts agree that symptoms definitely can occur at blood lead levels of 60 μg/100 g whole blood and therefore recommend a 40 μg/100 g maximum. The central nervous system effects frequently are not reversible following discontinued exposure or chelation therapy and when improvement does occur, it is almost always only partial.

The peripheral neuropathy resulting from lead exposure characteristically involves only motor function with minimal sensory damage and has a marked predilection for the extensor muscles of the most active extremity. The peripheral neuropathy can occur with varying degress of severity. The earliest and mildest form which can be detected in workers with blood lead levels as low as 50 μg/100 g is manifested by slowing of motor nerve conduction velocity often without clinical symptoms. With progression of the neuropathy there is development of painless extensor muscle weakness usually involving the extensor muscles of the fingers and hand in most active upper extremity, followed in severe cases by wrist drop, or much less commonly, foot drop.

In addition to slowing of nerve conduction, electromyographical studies in patients with blood lead levels greater than 50 μg/100 g have demonstrated a decrease in the number of acting motor unit potentials, an increase in the duration of motor unit potentials, and spontaneous pathological activity including fibrillations and fasciculations. Whether these effects occur at levels of 40 μg/100 g is undetermined.

While the peripheral neuropathies can occasionally be reversed with therapy, again such recovery is not assured particularly in the more severe neuropathies and often improvement is only partial. The lack of reversibility is felt to be due in part to segmental demyelination.

3. *Gastrointestinal.* Lead may also affect the gastrointestinal system producing abdominal colic or diffuse abdominal pain, constipation, obstipation, diarrhea, anorexia, nausea and vomiting. Lead colic rarely develops at blood lead levels below 80 μg/100 g.

4. *Renal.* Renal toxicity represents one of the most serious health effects of lead poisoning. In the early stages of disease nuclear inclusion bodies can frequently be identified in proximal renal

tubular cells. Renal function remains normal and the changes in this stage are probably reversible. With more advanced disease there is progressive interstitial fibrosis and impaired renal function. Eventually extensive interstitial fibrosis ensues with sclerotic glomeruli and dilated and atropied proximal tubules; all represent end stage kidney disease. Azotemia can be progressive, eventually resulting in frank uremia necessitating dialysis. There is occasionally associated hypertension and hyperuricemia with or without gout.

Early kidney disease is difficult to detect. The urinalysis is normal in early lead nephropathy and the blood urea nitrogen and serum creatinine increase only when two-thirds of kidney function is lost. Measurement of creatinine clearance can often detect earlier disease as can other methods of measurement of glomerular filtration rate. An abnormal Ca-EDTA mobilization test has been used to differentiate between lead-induced and other nephropathies, but this procedure is not widely accepted. A form of Fanconi syndrome with aminoaciduria, glycosuria, and hyperphosphaturia indicating severe injury to the proximal renal tubules is occasionally seen in children.

5. *Reproductive effects.* Exposure to lead can have serious effects on reproductive function in both males and females. In male workers exposed to lead there can be a decrease in sexual drive, impotence, decreased ability to produce healthy sperm, and sterility. Malformed sperm (teratospermia), decreased number of sperm (hypospermia), and sperm with decreased motility (asthenospermia) can all occur. Teratospermia has been noted at mean blood lead levels of 53 μg/100 g and hypospermia and astenospermia at 41 μg/100 g. Furthermore, there appears to be a dose-response relationship for teratospermia in lead exposed workers.

Women exposed to lead may experience menstrual disturbances including dysmenorrhea, menorrhagia and amenorrhea. Following exposure to lead, women have a higher frequency of sterilty, premature births, spontaneous miscarriages, and stillbirths.

Germ cells can be affected by lead and cause genetic damage in the egg or sperm cells before conception and result in failure to implant, miscarriage, stillbirth, or birth defects.

Infants of mothers with lead poisoning have a higher mortality during the first year and suffer from lowered birth weights, slower growth, and nervous system disorders.

Lead can pass through the placental barrier and lead levels in the mother's blood are comparable to concentrations of lead in the umbilical cord at birth. Transplacental passage becomes detectable at 12-14 weeks of gestation and increases until birth.

There is little direct data on damage to the fetus from exposure to lead but it is generally assumed that the fetus and newborn would be at least as susceptible to neurological damage as young children. Blood lead levels of 50-60 μg/100 g in children can cause significant neurobehavioral impairments and there is evidence of hyperactivity at blood levels as low as 25 μg/100 g. Given the overall body of literature concerning the adverse health effects of lead in children, OSHA feels that the blood lead level in children should be maintained below 30 μg/100 g with a population mean of 15 μg/100 g. Blood lead levels in the fetus and newborn likewise should not exceed 30 μg/100 g.

Because of lead's ability to pass through the placental barrier and also because of the demonstrated adverse effects of lead on reproductive function on both the male and female as well as the risk of genetic damage of lead on both the ovum and sperm, OSHA recommends a 30 μg/100 g maximum permissible blood lead level in both males and females who wish to bear children.

6. *Other toxic effects.* Debate and research continue on the effects of lead on the human body. Hypertension has frequently been noted in occupationally exposed individuals although it is difficult to assess whether this is due to lead's adverse effects on the kidney or if some other mechanism is involved. Vascular and electrocardiographic changes have been detected but not been well characterized. Lead is thought to impair thyroid function and interfere with the pituitary-adrenal axis, but again these effects have not been well defined.

III. Medical Evaluation

The most important principle in evaluating a worker for any occupational disease including lead poisoning is a high index of suspicion on the part of the examining physician. As discussed in Section 2, lead can effect numerous organ systems and produce a wide array of signs and symptoms, most of which are non-specific and subtle in nature at least in the early stages of disease. Unless serious concern for lead toxicity is present, many of the early clues to diagnosis may easily be overlooked.

The crucial initial step in the medical evaluation is recognizing that a worker's employment can result in exposure to lead. The worker will frequently be able to define exposures to lead and lead containing materials but often will not volunteer this information unless specifically asked. In other situations the worker may not know of any exposures to lead but the suspicion might be raised on the part of the physician because of the industry or occupation of the worker. Potential occupational exposure to lead and its compounds occur in at least 120 occupations, including lead smelting, the manufacture of lead storage batteries, the manufacture of lead pigments and products containing pigments, solder manufacture, shipbuilding and ship repair, auto manufacturing, construction, and painting.

Once the possibility for lead exposure is raised, the focus can then be directed toward eliciting information from the medical history, physical exam, and finally from laboratory data to evaluate the worker for potential lead toxicity.

A complete and detailed work history is important in the initial evaluation. A listing of all previous employment with information on work processes, exposure to fumes or dust, known exposures to lead or other toxic substances, respiratory protection used, and previous medical surveillance should all be included in the worker's record. Where exposure to lead is suspected, information concerning on-the-job personal hygiene, smoking or eating habits in work areas, laundry procedures, and use of any protective clothing or respiratory protection equipment should be noted. A complete work history is essential in the medical evaluation of a worker with suspected lead toxicity, especially when long term effects such as neurotoxicity and nephrotoxicity are considered.

The medical history is also of fundamental importance and should include a listing of all past and current medical conditions, current medications including proprietary drug intake, previous surgeries and hospitalizations, allergies, smoking history, alcohol consumption, and also non-occupational lead exposures such as hobbies (hunting, riflery). Also known childhood exposures should be elicited. Any previous history of hemotological, neurological, gastrointestinal, renal, psychological, gynecological, genetic, or reproductive problems should be specifically noted.

A careful and complete review of systems must be performed to assess both recognized complaints and subtle or slowly acquired symptoms which the worker might not appreciate as being

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significant. The review of symptoms should include the following:

General—Weight loss, fatigue, decreased appetite.

Head, Eyes, Ears, Nose, Throat (HEENT)—headaches, visual disturbances or decreased visual acuity, hearing deficits or tinnitus, pigmentation of the oral mucosa, or metallic taste in mouth.

Cardio-pulmonary—shortness of breath, cough, chest pains, palpitations, or orthopnea.

Gastrointestinal—nausea, vomiting, heartburn, abdominal pain, constipation or diarrhea.

Neurological—irritability, insomnia, weakness (fatigue), dizziness, loss of memory, confusion, hallucinations, incoordination, ataxia, decreased strength in hands or feet, disturbances in gait, difficulty in climbing stairs, or seizures.

Hematologic—pallor, easy fatigability, abnormal blood loss, melena.

Reproductive (male and female and spouse where relevant)—history of infertility, impotence, loss of libido, abnormal menstrual periods, history of miscarriages, stillbirths, or children with birth defects.

Musculo-skeletal—muscle and joint pains.

The physical examination should emphasize the neurological, gastrointestinal, and cardiovascular systems. The worker's weight and blood pressure should be recorded and the oral mucosa checked for pigmentation characteristic of a possible Burtonian or lead line on the gingiva. It should be noted, however, that the lead line may not be present even in severe lead poisoning if good oral hygiene is practiced.

The presence of pallor on skin examination may indicate an anemia, which if severe might also be associated with a tachycardia. If an anemia is suspected, an active search for blood loss should be undertaken including potential blood loss through the gastrointestinal tract.

A complete neurological examination should include an adequate mental status evaluation including a search for behavioral and psychological disturbances, memory testing, evaluation for irritability, insomnia, hallucinations, and mental clouding. Gait and coordination should be examined along with close observation for tremor. A detailed evaluation of peripheral nerve function including careful sensory and motor function testing is warranted. Strength testing particularly of extensor muscle groups of all extremities is of fundamental importance.

Cranial nerve evaluation should also be included in the routine examination.

The abdominal examination should include auscultation for bowel sounds and abdominal bruits and palpation for organomegaly, masses, and diffuse abdominal tenderness.

Cardiovascular examination should evaluate possible early signs of congestive heart failure. Pulmonary status should be addressed particularly if respirator protection is contemplated.

As part of the medical evaluation, the lead standard requires the following laboratory studies:

1. Blood lead level
2. Hemoglobin and hematocrit determinations, red cell indices, and examination of the peripheral blood smear to evaluate red blood cell morphology
3. Blood urea nitrogen
4. Serum creatinine
5. Routine urinalysis with microscopic examination
6. A zinc protoporphyrin level

In addition to the above, the physician is authorized to order any further laboratory or other tests which he or she deems necessary in accordance with sound medical practice. The evaluation must also include pregnancy testing or laboratory evaluation of male fertility if requested by the employee.

Additional tests which are probably not warranted on a routine basis but may be appropriate when blood lead and ZPP levels are equivocal include delta aminolevulinic acid and coproporphyrin concentrations in the urine, and dark-field illumination for detection of basophilic stippling in red blood cells.

If an anemia is detected further studies including a careful examination of the peripheral smear, reticulcyte count, stool for occult blood, serum iron, total iron binding capacity, bilrubin, and, if appropriate, vitamin B12 and folate may be of value in attempting to identify the cause of the anemia.

If a peripheral neuropathy is suspected, nerve condition studies are warranted both for diagnosis and as a basis to monitor any therapy.

If renal disease is questioned, a 24 hour urine collection for creatinine clearance, protein, and electrolytes may be indicated. Elevated uric acid levels may result from lead-induced renal disease and a serum uric acid level might be performed.

An electrocardiogram and chest x-ray may be obtained as deemed appropriate.

Sophisticated and highly specialized testing should not be done routinely and where indicated should be under the direction of a specialist.

IV. Laboratory Evaluation

The blood lead level at present remains the single most important test to monitor lead exposure and is the test used in the medical surveillance program under the lead standard to guide employee medical removal. The ZPP has several advantages over the blood lead level. Because of its relatively recent development and the lack of extensive data concerning its interpretation, the ZPP currently remains an ancillary test.

This section will discuss the blood lead level and ZPP in detail and will outline their relative advantages and disadvantages. Other blood tests currently available to evaluate lead exposure will also be reviewed.

The blood lead level is a good index of current or recent lead absorption when there is no anemia present and when the worker has not taken any chelating agents. However, blood lead levels along with urinary lead levels do not necessarily indicate the total body burden of lead and are not adequate measures of past exposure. One reason for this is that lead has a high affinity for bone and up to 90% of the body's total lead is deposited there. A very important component of the total lead body burden is lead in soft tissue (liver, kidney, and brain). This fraction of the lead body burden, the biologically active lead, is not entirely reflected by blood lead levels since it is a function of the dynamics of lead absorption, distribution, deposition in bone and excretion. Following discontinuation of exposure to lead, the excess body burden is only slowly mobilized from bone and other relatively stable body stores and excreted. Consequently, a high blood lead level may only represent recent heavy exposure to lead without a significant total body excess and likewise a low blood lead level does not exclude an elevated total body burden of lead.

Also due to its correlation with recent exposures, the blood lead level may vary considerably over short time intervals.

To minimize laboratory error and erroneous results due to contamination, blood specimens must be carefully collected after thorough cleaning of the skin with appropriate methods using lead-free blood containers and analyzed by a reliable laboratory. Under the standard, samples must be analyzed in laboratories which are approved by the Center for Disease Control (CDC) or which have received satisfactory grades in proficiency testing by the CDC in the previous year. Analysis is to be made using atomic absorption

spectrophotometry, anodic stripping, voltammetry, or any method which meets the accuracy requirements set forth by the standard.

The determination of lead in urine is generally considered a less reliable monitoring technique than analysis of whole blood primarily due to individual variability in urinary excretion capacity as well as the technical difficulty of obtaining accurate 24 hour urine collections. In addition, workers with renal insufficiency, whether due to lead or some other cause, may have decreased lead clearance and consequently urine lead levels may underestimate the true lead burden. Therefore, urine lead levels should not be used as a routine test.

The zinc protoporphyrin test, unlike the blood lead determination, measures an adverse metabolic effect of lead and as such is a better indicator of lead toxicity than the level of blood lead itself. The level of ZPP reflects lead absorption over the preceding 3 to 4 months, and therefore is a better indicator of lead body burden. The ZPP requires more time than the blood lead to read significantly elevated levels; the return to normal after discontinuing lead exposure is also slower. Furthermore, the ZPP test is simpler, faster, and less expensive to perform and no contamination is possible. Many investigators believe it is the most reliable means of monitoring chronic lead absorption.

Zinc protoporphyrin results from the inhibition of the enzyme ferrochelatase which catalyzes the insertion of an iron molecule into the protoporphyrin molecule, which then becomes heme. If iron is not inserted into the molecule then zinc, having a greater affinity for protoporphyrin, takes the place of the iron, forming ZPP.

An elevation in the level of circulating ZPP may occur at blood lead levels as low as 20-30 μg/100 g in some workers. Once the blood lead level has reached 40 μg/100 g there is more marked rise in the ZPP value from its normal range of less than 100 μg/100 ml. Increases in blood lead levels beyond 40 μg/100 g are associated with exponential increases in ZPP.

Whereas blood lead levels fluctuate over short time spans, ZPP levels remain relatively stable. ZPP is measured directly in red blood cells and is present for the cell's entire 120 day life-span. Therefore, the ZPP level in blood reflects the average ZPP production over the previous 3-4 months and consequently the average lead exposure during that time interval.

It is recommended that a hematocrit be determined whenever a confirmed ZPP or 50 μg/100 ml whole blood is obtained to rule out a significant underlying anemia. If the ZPP is in excess of 100 μg/100 ml and not associated with abnormal elevations in blood lead levels, the laboratory should be checked to be sure that blood leads were determined using atomic absorption spectrophotometry, anodic stripping, voltammetry, or any method which meets the accuracy requirements set forth by the standard or by a CDC certified laboratory which is experienced in lead level determinations. Repeat periodic blood lead studies should be obtained in all individuals with elevated ZPP levels to be certain that an associated elevated blood lead level has not been missed due to transient fluctuations in blood leads.

ZPP has a characteristic flourescence spectrum with a peak at 594 nm which is detectable with a hematoflourimeter. The hematoflourimeter is accurate and portable and can provide on-site, instantaneous results for workers who can be frequently tested via a finger prick.

However, careful attention must be given to calibration and quality control procedures. Limited data on blood lead—ZPP correlations and the ZPP levels which are associated with the adverse health effects discussed in Section 2 are the major limitations of the test. Also it is difficult to correlate ZPP levels with environmental exposure and there is some variation of response with age and sex. Nevertheless, the ZPP promises to be an important diagnostic test for the early detection of lead toxicity and its value will increase as more data is collected regarding its relationship to other manifestations of lead poisoning.

Levels of delta-aminolevulinic acid (ALA) in the urine are also used as a measure of lead exposure. Increasing concentrations of ALA are believed to result from the inhibition of the enzyme delta-aminolevulinic acid dehydrase (ALA-D). Although the test is relatively easy to perform, inexpensive, and rapid, the disadvantages include variability in results, the necessity to collect a complete 24 hour urine sample which has a specific gravity greater than 1.010, and also the fact that ALA decomposes in the presence of light.

The pattern of porphyrin excretion in the urine can also be helpful in identifying lead intoxication. With lead poisoning, the urine concentrations of coproporphyrins I and II, porphobilinogen and uroporphyrin I rise. The most important increases, however, is that of coproporphyrins III; levels may exceed 5,000 μg/1 in the urine in lead poisoned individuals, but its correlation with blood lead levels and ZPP are not as good as those of ALA. Increases in urinary porphyrins are not diagnostic of lead toxicity and may be seen in porphyria, some liver diseases, and in patients with high reticulocyte counts.

Summary. The Occupational Safety and Health Administration's standard for inorganic lead places significant emphasis on the medical surveillance of all workers exposed to levels of inorganic lead above the action level of 30 μm^3 TWA. The physician has a fundamental role in this surveillance program, and in the operation of the medical removal protection program.

Even with adequate worker education on the adverse health effects of lead and appropriate training in work practices, personal hygiene and other control measures, the physician has a primary responsibility for evaluating potential lead toxicity in the worker. It is only through a careful and detailed medical and work history, a complete physical examination and appropriate laboratory testing that an accurate assessment can be made. Many of the adverse health effects of lead toxicity are either irreversible or only partially reversible and therefore early detection of disease is very important.

This document outlines the medical monitoring program as defined by the occupational safety and health standard for inorganic lead. It reviews the adverse health effects of lead poisoning and describes the important elements of the history and physical examinations as they relate to these adverse effects. Finally, the appropriate laboratory testing for evaluating lead exposure and toxicity is presented.

It is hoped that this review and discussion will give the physician a better understanding of the OSHA standard with the ultimate goal of protecting the health and well-being of the worker exposed to lead under his or her care.

[FR Doc. 79-32637 Files 10-22-79; 8:45 am]

Z

This appendix specifies the only allowable qualitative fit test protocols permissible for compliance with paragraph (f)(3)(ii).

I. Isoamyl Acetate Protocol

A. Odor threshold screening.

1. Three 1-liter glass jars with metal lids (e.g., Mason or Bell jars) are required.

2. Odor free water (e.g., distilled or spring water) at approximately 25° C shall be used for the solutions.

3. The isoamyl acetate (IAA) (also known as isopentyl acetate) stock solution is prepared by adding 1 cc of pure IAA to 800 cc of odor free water in a 1-liter jar and shaking for 30 seconds. The solution shall be prepared new at least weekly.

4. The screening test shall be conducted in a room separate from the room used for actual fit testing. The two rooms shall be well ventilated but may not be connected to the same recirculating ventilation system.

5. The odor test solution is prepared in a second jar by placing .4 cc of the stock solution into 500 cc of odor free water using a clean dropper or pipette. Shake for 30 seconds and allow to stand for two to three minutes so that the IAA concentration above the liquid may reach equilibrium. This solution may be used for only one day.

6. A test blank is prepared in a third jar by adding 500 cc of odor free water.

7. The odor test and test blank jars shall be labelled 1 and 2 for jar identification. If the labels are put on the lids they can be periodically *dried off* and switched to avoid people thinking the same jar always has IAA.

8. The following instructions shall be typed on a card and placed on the table in front of the two test jars (i.e., 1 and 2);

"The purpose of this test is to determine if you can smell banana oil at a low concentration. The two bottles in front of you contain water. One of these bottles also contains a small amount of banana oil. Be sure the covers are on tight, then shake each bottle for two seconds. Unscrew the lid of each bottle, one at a time, and sniff at the mouth of the bottle. Indicate to the test conductor which bottle contains banana oil."

9. The mixtures used in the IAA odor detection test shall be prepared in an area separate from where the test is performed, in order to prevent olfactory fatigue in the subject.

10. If the test subject is unable to correctly identify the jar containing the odor test solution, the IAA QLFT may not be used.

11. If the test subject correctly identifies the jar containing the odor test solution he may proceed to respirator selection and fit testing.

B. Respirator selection.

1. The test subject shall be allowed to select the most comfortable respirator from a large array of various sizes and manufacturers that includes at least three sizes of elastomeric half facepieces and units of at least two manufacturers.

2. The selection process shall be conducted in a room separate from the fit-test chamber to prevent odor fatigue. Prior to the selection process, the test subject shall be shown how to put on a respirator, how it should be positioned on the face, how to set strap tension and how to assess a "comfortable" respirator. A mirror shall be available to assist the subject in evaluating the fit and positioning of the respirator. This may not constitute his formal training on respirator use, only a review.

3. The test subject shall understand that he is being asked to select the respirator which provides the most comfortable fit for him. Each respirator represents a different size and shape and, if fit properly, will provide adequate protection.

4. The test subject holds each facepiec e up to his face and eliminates those which are obviously not given a comfortable fit. Normally, selection will begin with a half-mask and if a fit cannot be found here, the subject will be asked to go to the full facepiece respirators. (A small percentage of users will not be able to wear any half-mask.)

5. The more comfortable facepieces are recorded; the most comfortable mask is donned and *worn at least five minutes* to assess comfort. Assistance in assessing comfort can be given by discussing the points in #6 below. If the test subject is not familiar with using a particular respirator, he shall be directed to don the mask several times and to adjust the straps each time, so that he becomes adept at setting proper tension on the straps.

6. Assessment of comfort shall include reviewing the following points with the test subject:

- Chin properly placed.
- Positioning of mask on nose.
- Strap tension.
- Fit across nose bridge.
- Room for safety glasses.
- Distance from nose to chin.
- Room to talk.
- Tendency to slip.
- Cheeks filled out.
- Self-observation in mirror.
- Adequate time for assessment.

7. The test subject shall conduct the conventional negative and positive-pressure fit checks (e.g., see ANSI Z88.2 — 1980). Before conducting the negative- or positive-pressure checks, the subject shall be told to "seat" his mask by rapidly moving the head side-to-side and up and down, taking a few deep breaths.

8. The test subject is now ready for fit testing.

9. After passing the fit test, the test subject shall be questioned again regarding the comfort of the respirator. If it has become uncomfortable, another model of respirator shall be tried.

10. The employee shall be given the opportunity to select a different facepiece and be retested if during the first two weeks of on-the-job wear the chosen facepiece becomes unacceptably uncomfortable.

C. Fit test.

1. The fit test chamber shall be substantially similar to a clear 55 gallon drum liner suspended inverted over a 2-foot diameter frame, so that the top of chamber is about 6 inches above the test subject's head. The inside top center of the chamber shall have a small hook attached.

2. Each respirator used for the fitting and fit testing shall be equipped with organic vapor cartridges or offer protection against organic vapors. The cartridges or masks shall be changed at least weekly.

3. After selecting, donning, and properly adjusting a respirator himself, the test subject shall wear it to the fit testing room. This room shall be separate from the room used for odor threshold screening and respirator selection, and shall be well ventilated, as by an exhaust fan or lab hook, to prevent room contamination.

4. A copy of the following test exercises and rainbow (or equally effective) passage shall be taped to the inside of the test chamber:

Test Exercises

i. Normal breathing.

ii. Deep breathing. Be certain breaths are *deep* and *regular*.

iii. Turning head from side-to-side. Be certain movement is complete. Alert the test subject not to bump the respira-

tor on the shoulders. Have the test subject inhale when his head is at either side.

iv. Nodding head up-and-down. Be certain motions are complete and made about every second. Alert the test subject not to bump the respirator on the chest. Have the test subject inhale when his head is in the fully up position.

v. Talking. Talk aloud and slowly for several minutes. The following paragraph is called the Rainbow Passage. Reading it will result in a wide range of facial movements, and thus be useful to satisfy this requirement. Alternative passages which serve the same purpose may also be used.

Rainbow Passage

When the sunlight strikes raindrops in the air, they act like a prism and form a rainbow. The rainbow is a division of white light into many beautiful colors. These take the shape of a long round arch, with its path high above, and its two ends apparently beyond the horizon. There is, according to legend, a boiling pot of gold at one end. People look, but no one ever finds it. When a man looks for something beyond reach, his friends say he is looking for the pot of gold at the end of the rainbow.

vi. Normal breathing.

5. Each test subject shall wear his respirator for at least 10 minutes before starting the fit test.

6. Upon entering the test chamber, the test subject shall be given a 6-inch by 5-inch piece of paper towel or other porous absorbent single-ply material, folded in half and wetted with three-quarters of one cc of pure IAA. The test subject shall hang the wet towel on the hook at the top of the chamber.

7. Allow two minutes for the IAA test concentration to be reached before starting the fit-test exercises. This would be an appropriate time to talk with the test subject, to explain the fit test, the importance of his cooperation, the purpose for the head exercises, or to demonstrate some of the exercises.

8. Each exercise described in No. 4 above shall be performed for at least one minute.

9. If at any time during the test, the subject detects the banana-like odor of IAA, he shall quickly exit from the test chamber and leave the test area to avoid olfactory fatigue.

10. Upon returning to the selection room, the subject shall remove the respirator, repeat the odor sensitivity test, select and put on another respirator, return to the test chamber, etc. The process continues until a respirator that fits well has been found. Should the odor sensitivity test be failed, the subject shall wait about 5 minutes before retesting. Odor sensitivity will usually have returned by this time.

11. If a person cannot be fitted with the selection of half-mask respirators, include full facepiece models in the selection process. When a respirator is found that passes the test, its efficiency shall be demonstrated for the subject by having him break the face seal and take a breath before exiting the chamber.

12. When the test subject leaves the chamber he shall remove the saturated towel, returning it to the test conductor. To keep the area from becoming contaminated, the used towels shall be kept in a self-sealing bag. There is no significant IAA concentration buildup in the test chamber from subsequent tests.

13. Persons who have successfully passed this fit test may be assigned the use of the tested respirator in atmospheres with up to 10 times the PEL of airborne lead. In other words this IAA protocol may be used to assign a protection factor no higher than 10.

II. Saccharin Solution Aerosol Protocol

A. Taste threshold screening.

1. Threshold screening, and fit testing employees shall use an enclosure about the head and shoulders that is approximately 12 inches in diameter by 14 inches tall with at least the front portion clear and that allows free movement of the head when a respirator is worn. An enclosure substantially similar to the 3M hood assembly of part # FT 14 and # FT 15 combined is adequate.

2. The test enclosure shall have a three-quarter inch hole in front of the test subject's nose and mouth area to accommodate the nebulizer nozzle.

3. The entire screening and testing procedures shall be explained to the test subject prior to the conduct of the screening test.

4. The test subject shall don the test enclosure. For the threshold screening test, he shall breathe through his open mouth with tongue extended.

5. Using a DeVilbiss Model 40 Inhalation Medication Nebulizer, the test conductor shall spray the threshold check solution into the enclosure. This nebulizer shall be clearly marked to distinguish it from the fit test solution nebulizer.

6. The threshold check solution consists of 0.83 grams of sodium saccharin, USP in water. It can be prepared by putting 1 cc of the test solution (see C6 below) in 100 cc of water.

7. To produce the aerosol, the nebulizer bulb is firmly squeezed so that it collapses completely then is released and allowed to fully expand.

8. Ten squeezes are repeated rapidly and then the test subject is asked whether the saccharin can be tasted.

9. If the first response is negative, ten more squeezes are repeated rapidly and the test subject is again asked whether the saccharin is tasted.

10. If the second response is negative, ten more squeezes are repeated rapidly and the test subject is again asked whether the saccharin is tasted.

11. The test conductor will take note of the number of squeezes required to elicit a taste response.

12. If the saccharin is not tasted after 30 squeezes (Step 9), the test subject may not perform the saccharin fit test.

13. If a taste response is elicited, the test subject shall be asked to take note of the taste for reference in the fit test.

14. Correct use of the nebulizer means that approximately 1 cc of liquid is used at a time in the nebulizer body.

15. The nebulizer shall be thoroughly rinsed in water, shaken dry, and refilled at least each morning and afternoon or at least every four hours.

B. Respirator selection.

Respirators shall be selected as described in section IB above, except that each respirator shall be equipped with a particular filter cartridge.

C. Fit test.

1. The fit test uses the same enclosure described in B1 and B2 above.

2. Each test subject shall wear his respirator for at least 10 minutes before starting the fit test.

3. The test subject shall don the enclosure while wearing the respirator selected in section A above. This respirator shall be properly adjusted and equipped with a particular filter cartridge.

4. The test subject may not eat, drink (except plain water), or chew gum for 15 minutes before the test.

5. A second DeVilbiss Model 40 Inhalation Medication Nebulizer is used to spray the fit test solution into the enclosure. This nebulizer shall be clearly marked to distinguish it from the screening test solution nebulizer.

6. The fit test solution is prepared by adding 83 grams of sodium saccharin to 100 cc of warm water.

7. As before, the test subject shall breathe through the open mouth with tongue extended.

8. The nebulizer is inserted into the hole in the front of the enclosure and the fit test solution is sprayed into the enclosure using the same technique as for the taste threshold screening and the same number of squeezes required to elicit a taste response in the screening (see B10 above).

9. After generation of the aerosol, the test subject shall be instructed to perform the following exercises for one minute each.

i. Normal breathing.

ii. Deep breathing. Be certain breaths are *deep* and *regular*.

iii. Turning head from side-to-side. Be certain movement is complete. Alert the test subject not to bump the respirator on the shoulders. Have the test subject inhale when his head is at either side.

iv. Nodding head up-and-down. Be certain motions are complete. Alert the test subject not to bump the respirator on the chest. Have the test subject inhale when his head is in the fully up position.

v. Talking. Talk aloud and slowly for several minutes. The following paragraph is called the Rainbow Passage. Reading it will result in a wide range of facial movements, and thus be useful to satisfy this requirement. Alternative passages which serve the same purpose may also be used.

Rainbow Passage

When the sunlight strikes raindrops in the air, they act like a prism and form a rainbow. The rainbow is a division of white light into many beautiful colors. These take the shape of a long round arch, with its path high above, and its two ends apparently beyond the horizon. There is, according to legend, a boiling pot of gold at one end. People look, but no one ever finds it. When a man looks for something beyond his reach, his friends say he is looking for the pot of gold at the end of the rainbow.

10. Every 30 seconds, the aerosol concentration shall be replenished using one-half the number of squeezes as initially (C8).

11. The subject shall so indicate to the test conductor if at any time during the fit test the taste of saccharin is detected.

12. If the saccharin is detected, the fit is deemed unsatisfactory and a different respirator shall be tried.

13. Successful completion of the test protocol shall allow the use of the tested respirator in contaminated atmospheres up to 10 times the PEL. In other words, this protocol may be used to assign protection factors no higher than ten.

III. Irritant Fume Protocol

A. Respirator selection.

Respirators shall be selected as described in section IB above, except that each respirator shall be equipped with high efficiency-acid gas-organic vapor cartridges.

B. Fit test.

1. The test subject shall be allowed to smell a weak concentration of isoamyl acetate and of the irritant smoke to familiarize him with the characteristic odor of each.

2. The test subject shall properly don the respirator selected as above, and wear it for at least 10 minutes before starting the fit test.

3. The test conductor shall review this protocol with the test subject before testing.

4. The test subject shall perform the conventional positive pressure and negative pressure fit checks. Failure of either check shall be cause to select an alternative respirator.

5. A simplified isoamyl acetate based fit test shall be performed using ampules of IAA such as the Norton Respirator Fit Test Ampules or equivalent. Pass the ampule around the perimeter of the respirator at the junction of the facepiece and face. If leakage is detected, readjust the respirator. If leakage persists the respirator is rejected.

6. If no odor of IAA is detected the irritant smoke test shall be administered.

7. Break both ends of a ventilation smoke tube containing stannic oxychloride, such as the MSA part No. 5645, or equivalent. Attach a short length of tubing to one end of the smoke tube. Attach the other end of the smoke tube to a low pressure air pump set to deliver 200 milliliters per minute.

8. Advise the test subject that the smoke can be irritating to the eyes and instruct him to keep his eyes closed while the test is performed.

9. The test conductor shall direct the stream of irritant smoke from the tube towards the faceseal area of the test subject. He shall begin at least 12 inches from the facepiece and gradually move to within one inch, moving around the whole perimeter of the mask.

10. The following exercises shall be performed while the respirator seal is being challenged by the smoke. Each shall be performed for one minute.

i. Normal breathing.

ii. Deep breathing. Be certain breaths are *deep* and *regular*.

iii. Turning head from side-to-side. Be certain movement is complete. Alert the test subject not to bump the respirator on the shoulders. Have test subject inhale when his head is at either side.

iv. Nodding head up-and-down. Be certain motions are complete. Alert the test subject not to bump the respirator on the chest. Have the test subject inhale when his head is in the fully up position.

v. Talking — slowly and distinctly, count backwards from 100.

vi. Normal breathing.

11. If the irritant smoke produces an involuntary reaction (cough) by the test subject, the test conductor shall stop the test. In this case the test respirator is rejected and another respirator shall be selected.

12. Each test subject passing the smoke test without evidence of a response shall be given a sensitivity check of the smoke from the same tube to determine whether he reacts to the smoke. Failure to evoke a response shall void the fit test.

13. Steps B4, B9, and B10 of this protocol shall be performed in a location with exhaust ventilation sufficient to prevent general contamination of the testing area by the test agents (IAA, irritant smoke).

14. Respirators successfully tested by the protocol may be used in contaminated atmospheres up to ten times the PEL. In other words this protocol may be used to assign protection factors not exceeding ten.

Appendix A to Section 1910.1027 — Substance Safety Data Sheet

Cadmium

I. Substance Identification.

A. Substance: Cadmium.

B. 8-Hour, Time-weighted-average, Permissible Exposure Limit (TWA PEL):

1. TWA PEL: Five micrograms of cadmium per cubic meter of air 5 $\mu g/m^3$, time-weighted average (TWA) for an 8-hour workday.

C. Appearance: Cadmium metal-soft, blue-white, malleable, lustrous metal or grayish-white powder. Some cadmium compounds may also appear as a brown, yellow, or red powdery substance.

II. Health Hazard Data.

A. Routes of Exposure. Cadmium can cause local skin or eye irritation. Cadmium can affect your health if you inhale it or if you swallow it.

B. Effects of Overexposure.

1. Short-term (acute) exposure: Cadmium is much more dangerous by inhalation than by ingestion. High exposures to cadmium that may be immediately dangerous to life or health occur in jobs where workers handle large quantities of cadmium dust or fume; heat cadmium-containing compounds or cadmium-coated surfaces; weld with cadmium solders or cut cadmium-containing materials such as bolts.

2. Severe exposure may occur before symptoms appear. Early symptoms may include mild irritation of the upper respiratory tract, a sensation of constriction of the throat, a metallic taste and/or a cough. A period of 1-10 hours may precede the onset of rapidly progressing shortness of breath, chest pain, and flu-like symptoms with weakness, fever, headache, chills, sweating and muscular pain. Acute pulmonary edema usually develops within 24 hours and reaches a maximum by three days. If death from asphyxia does not occur, symptoms may resolve within a week.

3. Long-term (chronic) exposure. Repeated or long-term exposure to cadmium, even at relatively low concentrations, may result in kidney damage and an increased risk of cancer of the lung and of the prostate.

C. Emergency First Aid Procedures.

1. Eye exposure: Direct contact may cause redness or pain. Wash eyes immediately with large amounts of water, lifting the upper and lower eyelids. Get medical attention immediately.

2. Skin exposure: Direct contact may result in irritation. Remove contaminated clothing and shoes immediately. Wash affected area with soap or mild detergent and large amounts of water. Get medical attention immediately.

3. Ingestion: Ingestion may result in vomiting, abdominal pain, nausea, diarrhea, headache and sore throat. Treatment for symptoms must be administered by medical personnel. Under no circumstances should the employer allow any person whom he retains, employs, supervises or controls to engage in therapeutic chelation. Such treatment is likely to translocate cadmium from pulmonary or other tissue to renal tissue. Get medical attention immediately.

4. Inhalation: If large amounts of cadmium are inhaled, the exposed person must be moved to fresh air at once. If breathing has stopped, perform cardiopulmonary resuscitation. Administer oxygen if available. Keep the affected person warm and at rest. Get medical attention immediately.

5. Rescue: Move the affected person from the hazardous exposure. If the exposed person has been overcome, attempt rescue only after notifying at least one other person of the emergency and putting into effect established emergency procedures. Do not become a casualty yourself. Understand your emergency rescue procedures and know the location of the emergency equipment before the need arises.

III. Employee Information

A. Protective Clothing and Equipment.

1. Respirators: You may be required to wear a respirator for non-routine activities; in emergencies; while your employer is in the process of reducing cadmium exposures through engineering controls; and where engineering controls are not feasible. If respirators are worn in the future, they must have a joint Mine Safety and Health Administration (MSHA) and National Institute for Occupational Safety and Health (NIOSH) label of approval. Cadmium does not have a detectable odor except at levels well above the permissible exposure limits. If you can smell cadmium while wearing a respirator, proceed immediately to fresh air. If you experience difficulty breathing while wearing a respirator, tell your employer.

2. Protective Clothing: You may be required to wear impermeable clothing, gloves, foot gear, a face shield, or other appropriate protective clothing to prevent skin contact with cadmium. Where protective clothing is required, your employer must provide clean garments to you as necessary to assure that the clothing protects you adequately. The employer must replace or repair protective clothing that has become torn or otherwise damaged.

3. Eye Protection: You may be required to wear splash-proof or dust resistant goggles to prevent eye contact with cadmium.

B. Employer Requirements.

1. Medical: If you are exposed to cadmium at or above the action level, your employer is required to provide a medical examination, laboratory tests and a medical history according to the medical surveillance provisions under paragraph (1) of this standard. (See summary chart and tables in this Appendix A.) These tests shall be provided without cost to you. In addition, if you are accidentally exposed to cadmium under conditions known or suspected to constitute toxic exposure to cadmium, your employer is required to make special tests available to you.

2. Access to Records: All medical records are kept strictly confidential. You or your representative are entitled to see the records of measurements of your exposure to cadmium. Your medical examination records can be furnished to your personal physician or designated representative upon request by you to your employer.

3. Observation of Monitoring: Your employer is required to perform measurements that are representative of your exposure to cadmium and you or your designated representative are entitled to observe the monitoring procedure. You are entitled to observe the steps taken in the measurement procedure, and to record the results obtained. When the monitoring procedure is taking place in an area where respirators or personal protective clothing and equipment are required to be worn, you or your representative must also be provided with, and must wear the protective clothing and equipment.

C. Employee Requirements.-You will not be able to smoke, eat, drink, chew gum or tobacco, or apply cosmetics while working with cadmium in regulated areas. You will also not be able to carry or store tobacco products, gum, food, drinks or cosmetics in regulated areas because these products easily become contaminated with cadmium from the workplace and can therefore create another source of unnecessary cadmium exposure.

Some workers will have to change out of work clothes and shower at the end of the day, as part of their workday, in order to wash cadmium from skin and hair. Handwashing and cadmium- free eating facilities shall be provided by the employer and proper hygiene should always be performed before eating. It is also recommended that you do not smoke or use tobacco products, because among other things, they naturally contain cadmium. For further information, read the labeling on such products.

IV. Physician Information.

A. Introduction.-The medical surveillance provisions of paragraph (1) generally are aimed at accomplishing three main interrelated purposes: First, identifying employees at higher risk of adverse health effects from excess, chronic exposure to cadmium; second, preventing cadmium-induced disease; and third, detecting and minimizing existing cadmium-induced disease. The core of medical surveillance in this standard is the early and periodic monitoring of the employee's biological indicators of: (a) Recent exposure to cadmium; (b) cadmium body burden; and (c) potential and actual kidney damage associated with exposure to cadmium.

The main adverse health effects associated with cadmium overexposure are lung cancer and kidney dysfunction. It is not yet known how to adequately biologically monitor human beings to specifically prevent cadmium-induced lung cancer. By contrast, the kidney can be monitored to provide prevention and early detection of cadmium-induced kidney damage. Since, for non-carcinogenic effects, the kidney is considered the primary target organ of chronic exposure to cadmium, the medical surveillance provisions of this standard effectively focus on cadmium-induced kidney disease. Within that focus, the aim, where possible, is to prevent the onset of such disease and, where necessary, to minimize such disease as may already exist. The by-products of successful prevention of kidney disease are anticipated to be the reduction and prevention of other cadmium-induced diseases.

B. Health Effects.-The major health effects associated with cadmium overexposure are described below.

1. Kidney: The most prevalent nonmalignant disease observed among workers chronically exposed to cadmium is kidney dysfunction. Initially, such dysfunction is manifested as proteinuria. The proteinuria associated with cadmium exposure is most commonly characterized by excretion of low-molecular weight proteins (15,000 to 40,000 MW) accompanied by loss of electrolytes, uric acid, calcium, amino acids, and phosphate. The compounds commonly excreted include: beta-2-microglobulin (β2-M), retinol binding protein (RBP), immunoglobulin light chains, and lysozyme. Excretion of low molecular weight proteins are characteristic of damage to the proximal tubules of the kidney (Iwao et al., 1980).

It has also been observed that exposure to cadmium may lead to urinary excretion of high-molecular weight proteins such as albumin, immunoglobulin G, and glycoproteins (Ex. 29). Excretion of high-molecular weight proteins is typically indicative of damage to the glomeruli of the kidney. Bernard et al., (1979) suggest that damage to the glomeruli and damage to the proximal tubules of the kidney may both be linked to cadmium exposure but they may occur independently of each other.

Several studies indicate that the onset of low-molecular weight proteinuria is a sign of irreversible kidney damage (Friberg et al., 1974; Roels et al., 1982; Piscator 1984; Elinder et al., 1985; Smith et al., 1986). Above specific levels of ß2-M associated with cadmium exposure it is unlikely that β2-M levels return to normal even when cadmium exposure is eliminated by removal of the individual from the cadmium work environment (Friberg, Ex. 29, 1990).

Some studies indicate that such proteinuria may be progressive; levels of β2-M observed in the urine increase with time even after cadmium exposure has ceased. See, for example, Elinder et al., 1985. Such observations, however, are not universal, and it has been suggested that studies in which proteinuria has not been observed to progress may not have tracked patients for a sufficiently long time interval (Jarup, Ex. 8-661).

When cadmium exposure continues after the onset of proteinuria, chronic nephrotoxicity may occur (Friberg, Ex. 29). Uremia results from the inability of the glomerulus to adequately filter blood. This leads to severe disturbance of electrolyte concentrations and may lead to various clinical complications including kidney stones (L-140-50).

After prolonged exposure to cadmium, glomerular proteinuria, glucosuria, aminoaciduria, phosphaturia, and hypercalciuria may develop (Exs. 8-86, 4-28, 14-18). Phosphate, calcium, glucose, and amino acids are essential to life, and under normal conditions, their excretion should be regulated by the kidney. Once low molecular weight proteinuria has developed, these elements dissipate from the human body. Loss of glomerular function may also occur, manifested by decreased glomerular filtration rate and increased serum creatinine. Severe cadmium-induced renal damage may eventually develop into chronic renal failure and uremia (Ex. 55).

Studies in which animals are chronically exposed to cadmium confirm the renal effects observed in humans (Friberg et al., 1986). Animal studies also confirm problems with calcium metabolism and related skeletal effects which have been observed among humans exposed to cadmium in addition to the renal effects. Other effects commonly reported in chronic animal studies include anemia, changes in liver morphology, immunosuppression and hypertension. Some of these effects may be associated with co-factors. Hypertension, for example, appears to be associated with diet as well as cadmium exposure. Animals injected with cadmium have also shown testicular necrosis (Ex. 8-86B).

2. Biological Markers.

It is universally recognized that the best measures of cadmium exposures and its effects are measurements of cadmium in biological fluids, especially urine and blood. Of the two, CdU is conventionally used to determine body burden of cadmium in workers without kidney disease. CdB is conventionally used to monitor for recent exposure to cadmium. In addition, levels of CdU and CdB historically have been used to predict the percent of the population likely to develop kidney disease (Thun *et al.*, Ex. L-140-50; WHO, Ex. 8-674; ACGIH, Exs. 8-667, 140-50).

The third biological parameter upon which OSHA relies for medical surveillance is Beta-2-microglobulin in urine (β_2-M), a low molecular weight protein. Excess β_2-M has been widely accepted by physicians and scientists as a reliable indicator of functional damage to the proximal tubule of the kidney (Exs. 8-447, 144-3-C, 4-47, L-140-45, 19-43-A).

Excess β_2-M is found when the proximal tubules can no longer reabsorb this protein in a normal manner. This failure of the proximal tubules is an early stage of a kind of kidney disease that commonly occurs among workers with excessive cadmium exposure. Used in conjunction with biological test results indicating abnormal levels of CdU and CdB, the finding of excess β_2-M can establish for an examining physician that any existing kidney disease is probably cadmium-related (Trs. 6/6/90, pp. 82-86, 122, 134). The upper limits of normal levels for cadmium in urine and cadmium in blood are 3 μg Cd/gram creatinine in urine and 5 μgCd/liter whole blood, respectively. These levels were derived from broad-based population studies.

Three issues confront the physicians in the use of β_2-M as a marker of kidney dysfunction and material impairment. First, there are a few other causes of elevated levels of β_2-M not related to cadmium exposures, some of which may be rather common diseases and some of which are serious diseases (e.g., myeloma or transient flu, Exs. 29 and 8-086). These can be medically evaluated as alternative causes (Friberg, Ex. 29). Also, there are other factors that can cause β_2-M to degrade so that low levels would result in workers with tubular dysfunction. For example, regarding the degradation of β_2-M, workers with acidic urine (pH<6) might have β_2-M lev-

els that are within the "normal" range when in fact kidney dysfunction has occurred (Ex. L-140-1) and the low molecular weight proteins are degraded in acid urine. Thus, it is very important that the pH of urine be measured, that urine samples be buffered as necessary (See Appendix F.), and that urine samples be handled correctly, i.e., measure the pH of freshly voided urine samples, then if necessary, buffer to pH<6 (or above for shipping purposes), measure pH again and then, perhaps, freeze the sample for storage and shipping. (See also Appendix F.) Second, there is debate over the pathological significance of proteinuria, however, most world experts believe that β_2-M levels greater than 300 μg/g Cr are abnormal (Elinder, Ex. 55, Friberg, Ex. 29). Such levels signify kidney dysfunction that constitutes material impairment of health. Finally, detection of β_2-M at low levels has often been considered difficult, however, many laboratories have the capability of detecting excess β_2- M using simple kits, such as the Phadebas Delphia test, that are accurate to levels of 100 μg β_2-M/g Cr U (Ex. L-140-1).

Specific recommendations for ways to measure β_2-M and proper handling of urine samples to prevent degradation of β_2-M have been addressed by OSHA in Appendix F, in the section on laboratory standardization. All biological samples must be analyzed in a laboratory that is proficient in the analysis of that particular analyte, under paragraph (l)(1)(iv). (See Appendix F). Specifically, under paragraph (l)(1)(iv), the employer is to assure that the collecting and handling of biological samples of cadmium in urine (CdU), cadmium in blood (CdB), and beta-2 microglobulin in urine (β_2-M) taken from employees is collected in a manner that assures reliability. The employer must also assure that analysis of biological samples of cadmium in urine (CdU), cadmium in blood (CdB), and beta-2 microglobulin in urine (β_2-M) taken from employees is performed in laboratories with demonstrated proficiency for that particular analyte. (See Appendix F.)

3. Lung and Prostate Cancer.

The primary sites for cadmium-associated cancer appear to be the lung and the prostate (L-140-50). Evidence for an association between cancer and cadmium exposure derives from both epidemiological studies and animal experiments. Mortality from prostate cancer associated with cadmium is slightly elevated in several industrial cohorts, but the number of cases is small and there is not clear dose-response relationship. More substantive evidence exists for lung cancer.

The major epidemiological study of lung cancer was conducted by Thun *et al.*, (Ex. 4-68). Adequate data on cadmium exposures were available to allow evaluation of dose-response relationships between cadmium exposure and lung cancer. A statistically significant excess of lung cancer attributed to cadmium exposure was observed in this study even when confounding variables such as co-exposure to arsenic and smoking habits were taken into consideration (Ex. L-140-50).

The primary evidence for quantifying a link between lung cancer and cadmium exposure from animal studies derives from two rat bioassay studies; one by Takenaka *et al.*, (1983), which is a study of cadmium chloride and a second study by Oldiges and Glaser (1990) of four cadmium compounds.

Based on the above cited studies, the U.S. Environmental Protection Agency (EPA) classified cadmium as "B1", a probable human carcinogen, in 1985 (Ex. 4-4). The International Agency for Research on Cancer (IARC) in 1987 also recommended that cadmium be listed as "2A", a probable human carcinogen (Ex. 4-15). The American Conference of Governmental Industrial Hygienists (ACGIH) has recently recommended that cadmium be labeled as a carcinogen. Since 1984, NIOSH has concluded that cadmium is possibly a human carcinogen and has recommended that exposures be controlled to the lowest level feasible.

4. Non-carcinogenic Effects.

Acute pneumonitis occurs 10 to 24 hours after initial acute inhalation of high levels of cadmium fumes with symptoms such as fever and chest pain (Exs. 30, 8-86B). In extreme exposure cases pulmonary edema may develop and cause death several days after exposure. Little actual exposure measurement data is available on the level of airborne cadmium exposure that causes such immediate adverse lung effects, nonetheless, it is reasonable to believe a cadmium concentration of approximately 1 mg/m_3 over an eight hour period is "immediately dangerous" (55 FR 4052, ANSI; Ex. 8-86B).

In addition to acute lung effects and chronic renal effects, long term exposure to cadmium may cause other severe effects on the respiratory system. Reduced pulmonary function and chronic lung disease indicative of emphysema have been observed in workers who have had prolonged exposure to cadmium dust or fumes (Exs. 4-29, 4-22, 4-42, 4-50, 4-63). In a study of workers conducted by Kazantzis *et al.*, a statistically significant excess of worker deaths due to chronic bronchitis was found, which in his opinion was directly related to high cadmium exposures of 1 mg/m^3 or more (Tr. 6/8/90, pp. 156-157).

Cadmium need not be respirable to constitute a hazard. Inspirable cadmium particles that are too large to be respirable but small enough to enter the tracheobronchial region of the lung can lead to bronchoconstriction, chronic pulmonary disease, and cancer of that portion of the lung. All of these diseases have been associated with occupational exposure to cadmium (Ex. 8- 86B). Particles that are constrained by their size to the extra- thoracic regions of the respiratory system such as the nose and maxillary sinuses can be swallowed through mucocillary clearance and be absorbed into the body (ACGIH, Ex. 8-692). The impaction of these particles in the upper airways can lead to anosmia, or loss of sense of smell, which is an early indication of overexposure among workers exposed to heavy metals. This condition is commonly reported among cadmium-exposed workers (Ex. 8-86-B).

C. Medical Surveillance.

In general, the main provisions of the medical surveillance section of the standard, under paragraphs (l)(1)-(17) of the regulatory text, are as follows:

1. Workers exposed above the action level are covered;
2. Workers with intermittent exposures are not covered;
3. Past workers who are covered receive biological monitoring for at least one year;
4. Initial examinations include a medical questionnaire and biological monitoring of cadmium in blood (CdB), cadmium in urine (CdU), and Beta-2-microglobulin in urine (β_2-M);
5. Biological monitoring of these three analytes is performed at least annually; full medical examinations are performed biennially;
6. Until five years from the effective date of the standard, medical removal is required when CdU is greater than 15 μg/gram creatinine (g Cr), or CdB is greater than 15 μg/liter whole blood (lwb), or β_2-M is greater than 1500 μg/g Cr, and CdB is greater than 5 μg/lwb or CdU is greater than 3 μg/g Cr;
7. Beginning five years after the standard is in effect, medical removal triggers will be reduced;
8. Medical removal protection benefits are to be provided for up to 18 months;
9. Limited initial medical examinations are required for respirator usage;
10. Major provisions are fully described under section (l) of the regulatory text; they are outlined here as follows:

A. Eligibility

B. Biological monitoring

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C. Actions triggered by levels of CdU, CdB, and β_2-M (See Summary Charts and Tables in Attachment-1.)
D. Periodic medical surveillance
E. Actions triggered by periodic medical surveillance (See Appendix A Summary Chart and Tables in Attachment-1.)
F. Respirator usage
G. Emergency medical examinations
H. Termination examination
I. Information to physician
J. Physician's medical opinion
K. Medical removal protection
L. Medical removal protection benefits
M. Multiple physician review
N. Alternate physician review
O. Information employer gives to employee
P. Recordkeeping
Q. Reporting on OSHA form 200.

11. The above mentioned summary of the medical surveillance provisions, the summary chart, and tables for the actions triggered at different levels of CdU, CdB and β_2-M (in Appendix A Attachment- 1) are included only for the purpose of facilitating understanding of the provisions of paragraphs (l)(3) of the final cadmium standard. The summary of the provisions, the summary chart, and the tables do not add to or reduce the requirements in paragraph (l)(3).

D. Recommendations to Physicians.

1. It is strongly recommended that patients with tubular proteinuria are counseled on: The hazards of smoking; avoidance of nephrotoxins and certain prescriptions and over-the-counter medications that may exacerbate kidney symptoms; how to control diabetes and/or blood pressure; proper hydration, diet, and exercise (Ex. 19-2). A list of prominent or common nephrotoxins is attached. (See Appendix A Attachment-2.).

2. DO NOT CHELATE; KNOW WHICH DRUGS ARE NEPHRO -TOXINS OR ARE ASSOCIATED WITH NEPHRITIS.

3. The gravity of cadmium-induced renal damage is compounded by the fact there is no medical treatment to prevent or reduce the accumulation of cadmium in the kidney (Ex. 8-619). Dr. Friberg, a leading world expert on cadmium toxicity, indicated in 1992, that there is no form of chelating agent that could be used without substantial risk. He stated that tubular proteinuria has to be treated in the same way as other kidney disorders (Ex. 29).

4. After the results of a workers' biological monitoring or medical examination are received the employer is required to provide an information sheet to the patient, briefly explaining the significance of the results. (See Attachment 3 of this Appendix A.).

5. For additional information the physician is referred to the following additional resources:

a. The physician can always obtain a copy of the preamble, with its full discussion of the health effects, from OSHA's Computerized Information System (OCIS).

b. The Docket Officer maintains a record of the rulemaking. The Cadmium Docket (H-057A), is located at 200 Constitution Ave. NW., room N-2625, Washington, DC 20210; telephone: 202-523-7894.

c. The following articles and exhibits in particular from that docket (H-057A):

V. Information Sheet

The information sheet (Appendix A Attachment-3.) or an equally explanatory one should be provided to you after any biological monitoring results are reviewed by the physician, or where applicable, after any medical examination.

Exihit Number	Author and paper title
8-447	Lauwerys *et. al.,* Guide for physicians, "Health Maintenance of Workers Exposed to Cadmium," published by the Cadmium Council.
4-67	Takenaka, S., H. Oldiges, H. Konig, D. Hochrainer, G. Oberdorster. "Carcinogenicity of Cadmium Chloride Aerosols in Wistar Rats". *JNCI* 70:367-373, 1983. (32)
4-68	Thun, M.J., T.M. Schnoor, A.B. Smith, W.E. Halperin, R.A. Lemen. "Mortality Among a Cohort of U.S. Cadmium Production Workers-An Update." *JNCI* 74(2):325-33, 1985. (8)
4-25	Elinder, C.G., Kjellstrom, T., Hogstedt, C., *et al.,* "Cancer Mortality of Cadmium Workers." *Brit. J. Ind. Med.* 42:651- 655, 1985. (14)
4-26	Ellis, K.J. *et al.,* "Critical Concentrations of Cadmium in Human Renal Cortex: Dose Effect Studies to Cadmium Smelter Workers." *J. Toxicol. Environ. Health* 7:691-703, 1981. (76)
4-27	Ellis, K.J., S.H. Cohn and T.J. Smith. "Cadmium Inhalation Exposure Estimates: Their Significance with Respect to Kidney and Liver Cadmium Burden." *J. Toxicol. Environ. Health* 15:173-187, 1985.
4-28	Falck, F.Y., Jr., Fine, L.J., Smith, R.G., McClatchey, K.D., Annesley, T., England, B., and Schork, A.M. "Occupational Cadmium Exposure and Renal Status." *Am. J. Ind. Med.* 4:541, 1983. (64)
8-86A	Friberg, L., C.G. Elinder, *et al.,* "Cadmium and Health a Toxicological and Epidemiological Appraisal, Volume I, Exposure, Dose, and Metabolism." CRC Press, Inc., Boca Raton, FL, 1986. (Available from the OSHA Technical Data Center)
8-86B	Friberg, L., C.G. Elinder, *et al.,* "Cadmium and Health: A Toxicological and Epidemiological Appraisal, Volume II, Effects and Response." CRC Press, Inc., Boca Raton, FL, 1986. (Available from the OSHA Technical Data Center)
L-140-45.....	Elinder, C.G., "Cancer Mortality of Cadmium Workers", *Brit. J. Ind. Med.,* 42, 651-655, 1985.
L-140-50.....	Thun, M., Elinder, C.G., Friberg, L, "Scientific Basis for an Occupational Standard for Cadmium, *Am. J. Ind. Med.,* 20; 629-642, 1991.

APPENDIX A

Attachment 1 – Appendix A Summary Chart and Tables A and B of Actions Triggered by Biological Monitoring

Appendix A Summary Chart: Section (l)(3) Medical Surveillance

Categorizing Biological Monitoring Results.

(A) Biological monitoring results categories are set forth in Appendix A Table A for the periods ending December 31, 1998 and for the period beginning January 1, 1999.

(B) The results of the biological monitoring for the initial medical exam and the subsequent exams shall determine an employee's biological monitoring result category.

Actions Triggered by Biological Monitoring

(A)

(i) The actions triggered by biological monitoring for an employee are set forth in Appendix A Table B.

(ii) The biological monitoring results for each employee under section (1)(3) shall determine the actions required for that employee. That is, for any employee in biological monitoring category C, the employer will perform all of the actions for which there is an X in column C of Appendix A Table B.

(iii) An employee is assigned the alphabetical category ("A" being the lowest) depending upon the test results of the three biological markers.

(iv) An employee is assigned category A if monitoring results for all three biological markers fall at or below the levels indicated in the table listed for category A.

(v) An employee is assigned category B if any monitoring result for any of the three biological markers fall within the range of levels indicated in the table listed for category B, providing no result exceeds the levels listed for category B.

(vi) An employee is assigned category C if any monitoring result for any of the three biological markers are above the levels listed for category C.

(B) The user of Appendix A Tables A and B should know that these tables are provided only to facilitate understanding of the relevant provisions of paragraph (l)(3) of this section. Appendix A Tables A and B are not meant to add to or subtract from the requirements of those provisions.

Appendix A Table A Categorization of Biological Monitoring Results

Applicable Through 1998 Only

Biological marker	Monitoring result categories		
	A	B	C
Cadmium in urine (CdU) (μg/g creatinine)	≤3	>3 and ≤15	>15
β_2-microglobulin (β_2-M) (μg/g creatinine)	≤300	>300 and ≤1500	>1500*
Cadmium in blood (CdB) (μg/liter whole blood)	≤5	>5 and ≤15	>15

* If an employee's β_2-M levels are above 1,500 μg/g creatinine, in order for mandatory medical removal to be required (See Appendix A Table B.), either the employee's CdU level must also be >3 μg/g creatinine or CdB level must also be >5 μg/liter whole blood.

Applicable Beginning January 1, 1999

Biological marker	Monitoring result categories		
	A	B	C
Cadmium in urine (CdU) (μg/g creatinine)	≤3	>3 and ≤7	>7
β_2-microglobulin (β_2-M) (μg/g creatinine)	≤300	>300 and ≤750	>750*
Cadmium in blood (CdB) (μg/liter whole blood)	≤5	>5 and ≤10	>10

* If an employee's β_2-M levels are above 750 μg/g creatinine, in order for mandatory medical removal to be required (See Appendix A Table B.), either the employee's CdU level must also be 3 μg/g creatinine or CdB level must also be 5 μg/liter whole blood.

Appendix A Table B-Actions Determined by Biological Monitoring.

This table presents the actions required based on the monitoring result in Appendix A Table A. Each item is a separate requirement in citing non-compliance. For example, a medical examination within 90 days for an employee in category B is separate from the requirement to administer a periodic medical examination for category B employees on an annual basis.

Appendix A Table Appendix A-Attachment-2: List of Medications

A list of the more common medications that a physician, and the employee, may wish to review is likely to include some of the following: (1) Anticonvulsants: Paramethadione, phenytoin, trimethadone; (2) antihypertensive drugs: Captopril, methyldopa; (3) antimicrobials: Aminoglycosides, amphotericin B, cephalosporins, ethambutol; (4) antineoplastic agents: Cisplatin, methotrexate, mitomycin-C, nitrosoureas, radiation; (5) sulfonamide diuretics: Acetazolamide, chlorthalidone, furosemide, thiazides; (6) halogenated alkanes, hydrocarbons, and solvents that may occur in some settings: Carbon tetrachloride, ethylene glycol, toluene; iodinated radiographic contrast media; nonsteroidal anti-inflammatory drugs; and, (7) other miscellaneous compounds: Acetominophen, allopurinol, amphetamines, azathioprine, cimetidine,cyclosporine, lithium, methoxyflurane, methysergide, D-penicillamine, phenacetin, phenendione. A list of drugs associated with acute interstitial nephritis includes: (1) Antimicrobial drugs: Cephalosporins, chloramphenicol, colistin, erythromycin, ethambutol, isoniazid, para-aminosalicylic acid, penicillins, polymyxin B, rifampin, sulfonamides, tetracyclines, and vancomycin; (2) other miscellaneous drugs: Allopurinol, antipyrene, azathioprine, captopril, cimetidine, clofibrate, methyldopa, phenindione, phenylpropanolamine, phenytoin, probenecid, sulfinpyrazone, sulfonamid diuretics, triamterene; and, (3) metals: Bismuth, gold.

This list have been derived from commonly available medical textbooks (e.g., Ex. 14-18). The list has been included merely to facilitate the physician's, employer's, and employee's understanding. The list does not represent an official OSHA opinion or policy regarding the use of these medications for particular employees. The use of such medications should be under physician discretion.

Attachment 3-Biological Monitoring and Medical Examination Results

Employee_____

Testing Date_____

Cadmium in Urine _____ µg/g Cr–Normal Levels: ≤3 µg/g Cr.

Cadmium in Blood _____ µg/lwb–Normal Levels: ≤5 µg/lwb.

Beta-2-microglobulin in Urine _____ µg/g Cr–Normal Levels: ≤300 µg/g Cr.

Physical Examination Results: N/A _____ Satisfactory _____ Unsatisfactory _____ (see physician again).

Physician's Review of Pulmonary Function Test: N/A _____ Normal _____ Abnormal _____.

Next biological monitoring or medical examination scheduled for _____

The biological monitoring program has been designed for three main purposes: 1) to identify employees at risk of adverse health effects from excess, chronic exposure to cadmium; 2) to prevent cadmium-induced disease(s); and 3) to detect and minimize existing cadmium-induced disease(s).

The levels of cadmium in the urine and blood provide an estimate of the total amount of cadmium in the body. The amount of a specific protein in the urine (beta-2-microglobulin) indicates changes in kidney function. All three tests must be evaluated together. A single mildly elevated result may not be important if testing at a later time indicates that the results are normal and the workplace has been evaluated to decrease possible sources of cadmium exposure. The levels of cadmium or beta-2-microglobulin may change over a period of days to months and the time needed for those changes to occur is different for each worker.

Required action	Monitoring result category		
	A[1]	B[1]	C[1]
(1) Biological monitoring:			
(a) Annual	X		
(b) Semiannual		X	
(c) Quarterly			X
(2) Medical examination:			
(a) Biennial	X		
(b) Annual		X	
(c) Semiannual			X
(d) Within 90 days		X	X
(3) Assess within two weeks:			
(a) Excess cadmium exposure		X	X
(b) Work practices		X	X
(c) Personal hygiene		X	X
(d) Respirator usage		X	X
(e) Smoking history		X	X
(f) Hygiene facilities		X	X
(g) Engineering controls		X	X
(h) Correct within 30 days		X	X
(i) Periodically assess exposures			X
(4) Discretionary medical removal		X	X
(5) Mandatory medical removal			X[2]

[1]For all employees covered by medical surveillance exclusively because of exposures prior to the effective date of this standard, if they are in Category A, the employer shall follow the requirements of paragraphs (l)(3) (i)(B) and (l)(4)(v)(A). If they are in Category B or C, the employer shall follow the requirements of paragraphs (l)(4)(v)(B)-(C).
[2]See footnote Appendix A Table A.

If the results for biological monitoring are above specific "high levels" [cadmium urine greater than 10 micrograms per gram of creatinine (μg/g Cr), cadmium blood greater than 10 micrograms per liter of whole blood (μg/lwb), or beta-2-microglobulin greater than 1000 micrograms per gram of creatinine (μg/g Cr)], the worker has a much greater chance of developing other kidney diseases.

One way to measure for kidney function is by measuring beta- 2-microglobulin in the urine. Beta-2-microglobulin is a protein which is normally found in the blood as it is being filtered in the kidney, and the kidney reabsorbs or returns almost all of the beta-2-microglobulin to the blood. A very small amount (less than 300 μg/g Cr in the urine) of beta-2-microglobulin is not reabsorbed into the blood, but is released in the urine. If cadmium damages the kidney, the amount of beta-2-microglobulin in the urine increases because the kidney cells are unable to reabsorb the beta-2-microglobulin normally. An increase in the amount of beta-2-microglobulin in the urine is a very early sign of kidney dysfunction. A small increase in beta-2-microglobulin in the urine will serve as an early warning sign that the worker may be absorbing cadmium from the air, cigarettes contaminated in the workplace, or eating in areas that are cadmium contaminated.

Even if cadmium causes permanent changes in the kidney's ability to reabsorb beta-2-microglobulin, and the beta-2-microglobulin is above the "high levels", the loss of kidney function may not lead to any serious health problems. Also, renal function naturally declines as people age. The risk for changes in kidney function for workers who have biological monitoring results between the "normal values" and the "high levels" is not well known. Some people are more cadmium-tolerant, while others are more cadmium-susceptible.

For anyone with even a slight increase of beta-2-microglobulin, cadmium in the urine, or cadmium in the blood, it is very important to protect the kidney from further damage. Kidney damage can come from other sources than excess cadmium-exposure so it is also recommended that if a worker's levels are "high" he/she should receive counseling about drinking more water; avoiding cadmium-tainted tobacco and certain medications (nephrotoxins, acetaminophen); controlling diet, vitamin intake, blood pressure and diabetes; etc.

Appendix B to – Substance Technical Guidelines for Cadmium

I. Cadmium Metal

A. Physical and Chemical Data.

1. Substance Identification.

Chemical name: Cadmium.

Formula: Cd.

Molecular Weight: 112.4.

Chemical Abstracts Service (CAS) Registry No.: 7740-43-9.

Other Identifiers: RETCS EU9800000; EPA D006; DOT 2570 53.

Synonyms: Colloidal Cadmium: Kadmium (German): CI 77180.

2. Physical data.

Boiling point: (760 mm Hg): 765 degrees C.

Melting point: 321 degrees C.

Specific Gravity: (H_2O = @ 20 °C): 8.64.

Solubility: Insoluble in water; soluble in dilute nitric acid and in sulfuric acid.

Appearance: Soft, blue-white, malleable, lustrous metal or grayish-white powder.

B. Fire, Explosion and Reactivity Data.

1. Fire.

Fire and Explosion Hazards: The finely divided metal is pyrophoric, that is the dust is a severe fire hazard and moderate explosion hazard when exposed to heat or flame. Burning material reacts violently with extinguishing agents such as water, foam, carbon dioxide, and halons.

Flash point: Flammable (dust).

Extinguishing media: Dry sand, dry dolomite, dry graphite, or sodimum chloride.

2. Reactivity.

Conditions contributing to instability: Stable when kept in sealed containers under normal temperatures and pressure, but dust may ignite upon contact with air. Metal tarnishes in moist air.

Incompatibilities: Ammonium nitrate, fused: Reacts violently or explosively with cadmium dust below 20 °C. Hydrozoic acid: Violent explosion occurs after 30 minutes. Acids: Reacts violently, forms hydrogen gas. Oxidizing agents or metals: Strong reaction with cadmium dust. Nitryl fluoride at slightly elevated temperature: Glowing or white incandescence occurs. Selenium: Reacts exothermically. Ammonia: Corrosive reaction. Sulfur dioxide: Corrosive reaction. Fire extinguishing agents (water, foam, carbon dioxide, and halons): Reacts violently. Tellurium: Incandescent reaction in hydrogen atmosphere.

Hazardous decomposition products: The heated metal rapidly forms highly toxic, brownish fumes of oxides of cadmium.

C. Spill, Leak and Disposal Procedures.

1. Steps to be taken if the materials is released or spilled. Do not touch spilled material. Stop leak if you can do it without risk. Do not get water inside container. For large spills, dike spill for later disposal. Keep unnecessary people away. Isolate hazard area and deny entry. The Superfund Amendments and Reauthorization Act of 1986 Section 304 requires that a release equal to or greater than the reportable quantity for this substance (1 pound) must be immediately reported to the local emergency planning committee, the state emergency response commission, and the National Response Center (800) 424-8802; in Washington, DC metropolitan area (202) 426-2675.

II. Cadmium Oxide.

A. Physical and Chemical Date.

1. Substance identification.

Chemical name: Cadmium Oxide.

Formula: CdO.

Molecular Weight: 128.4.

CAS No.: 1306-19-0.

Other Identifiers: RTECS EV1929500.

Synonyms: Kadmu tlenek (Polish).

2. Physical data.

Boiling point (760 mm Hg): 950 degrees C decomposes.

Melting point: 1500 °C.

Specific Gravity: (H_2O = 1@20 °C): 7.0.

Solubility: Insoluble in water; soluble in acids and alkalines.

Appearance: Red or brown crystals.

B. Fire, Explosion and Reactivity Data.

1. Fire.

Fire and Explosion Hazards: Negligible fire hazard when exposed to heat or flame.

Flash point: Nonflammable.

Extinguishing media: Dry chemical, carbon dioxide, water spray or foam.

2. Reactivity.

Conditions contributing to instability: Stable under normal temperatures and pressures.

Incompatibilities: Magnesium may reduce CdO2 explosively on heating.

Hazardous decomposition products: Toxic fumes of cadmium.

C. Spill Leak and Disposal Procedures.

1. Steps to be taken if the material is released or spilled. Do not touch spilled material. Stop leak if you can do it without

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risk. For small spills, take up with sand or other absorbent material and place into containers for later disposal. For small dry spills, use a clean shovel to place material into clean, dry container and then cover. Move containers from spill area. For larger spills, dike far ahead of spill for later disposal. Keep unnecessary people away. Isolate hazard area and deny entry. The Superfund Amendments and Reauthorization Act of 1986 Section 304 requires that a release equal to or greater than the reportable quantity for this substance (1 pound) must be immediately reported to the local emergency planning committee, the state emergency response commission, and the National Response Center (800) 424-8802; in Washington, DC metropolitan area (202) 426-2675.

III. Cadmium Sulfide.

A. Physical and Chemical Data.

1. Substance Identification.

Chemical name: Cadmium sulfide.

Formula: CdS.

Molecular weight: 144.5.

CAS No. 1306-23-6.

Other Identifiers: RTECS EV3150000.

Synonyms: Aurora yellow; Cadmium Golden 366; Cadmium Lemon Yellow 527; Cadmium Orange; Cadmium Primrose 819; Cadmium Sulphide; Cadmium Yellow; Cadmium Yellow 000; Cadmium Yellow Conc. Deep; Cadmium Yellow Conc. Golden; Cadmium Yellow Conc. Lemon; Cadmium Yellow Conc. Primrose; Cadmium Yellow Oz. Dark; Cadmium Yellow Primrose 47-1400; Cadmium Yellow 10G Conc.; Cadmium Yellow 892; Cadmopur Golden Yellow N; Cadmopur Yellow: Capsebon; C.I. 77199; C.I. Pigment Orange 20; CI Pigment Yellow 37; Ferro Lemon Yellow; Ferro Orange Yellow; Ferro Yellow; Greenockite; NCI-C02711.

2. Physical data.

Boiling point (760 mm. H_g): sublines in N_2 at 980 °C.

Melting point: 1750 degrees C (100 atm).

Specific Gravity: (H_2O = 1 @ 20 °C): 4.82.

Solubility: Slightly soluble in water; soluble in acid.

Appearance: Light yellow or yellow-orange crystals.

B. Fire, Explosion and Reactivity Data.

1. Fire.

Fire and Explosion Hazards: Neglible fire hazard when exposed to heat or flame.

Flash point: Nonflammable.

Extinguishing media: Dry chemical, carbon dioxide, water spray or foam.

2. Reactivity.

Conditions contributing to instability: Generally non-reactive under normal conditions. Reacts with acids to form toxic hydrogen sulfide gas.

Incompatibilities: Reacts vigorously with iodinemonochloride.

Hazardous decomposition products: Toxic fumes of cadmium and sulfur oxides.

C. Spill Leak and Disposal Procedures.

1. Steps to be taken if the material is released or spilled. Do not touch spilled material. Stop leak if you can do it without risk. For small, dry spills, with a clean shovel place material into clean, dry container and cover. Move containers from spill area. For larger spills, dike far ahead of spill for later disposal. Keep unnecessary people away. Isolate hazard and deny entry.

IV. Cadmium Chloride.

A. Physical and Chemical Data.

1. Substance Identification.

Chemical name: Cadmium chloride.

Formula: $CdC1_2$.

Molecular weight: 183.3.

CAS No. 10108-64-2.

Other Identifiers: RTECS EY0175000.

Synonyms: Caddy; Cadmium dichloride; NA 2570 (DOT); UI-CAD; dichlorocadmium.

2. Physical data.

Boiling point (760 mm H_g): 960 °C.

Melting point: 568 degrees C.

Specific Gravity: (H_2O = 1 @ 20 °C): 4.05.

Solubility: Soluble in water (140 g/100 cc); soluble in acetone.

Appearance: Small, white crystals.

B. Fire, Explosion and Reactivity Data.

1. Fire.

Fire and Explosion Hazards: Negligible fire and negligible explosion hazard in dust form when exposed to heat or flame.

Flash point: Nonflamable.

Extinguishing media: Dry chemical, carbon dioxide, water spray or foam.

2. Reactivity.

Conditions contributing to instability: Generally stable under normal temperatures and pressures.

Incompatibilities: Bromine triflouride rapidly attacks cadmium chloride. A mixture of potassium and cadmium chloride may produce a strong explosion on impact.

Hazardous decomposition products: Thermal ecompostion may release toxic fumes of hydrogen chloride, chloride, chlorine or oxides of cadmium.

C. Spill Leak and Disposal Procedures.

1. Steps to be taken if the materials is released or spilled. Do not touch spilled material. Stop leak if you can do it without risk. For small, dry spills, with a clean shovel place material into clean, dry container and cover. Move containers from spill area. For larger spills, dike far ahead of spill for later disposal. Keep unnecessary people away. Isolate hazard and deny entry. The Superfund Amendments and Reauthorization Act of 1986 Section 304 requires that a release equal to or greater than the reportable quantity for this substance (100 pounds) must be immediately reported to the local emergency planning committee, the state emergency response commission, and the National Response Center (800) 424-8802; in Washington, DC Metropolitan area (202) 426- 2675.

Appendix C to Section 1910.1027 – Qualitative and Quantitative Fit Testing Procedures

I. Fit Test Protocols

A. General: The employer shall include the following provisions in the fit test procedures. These provisions apply to both qualitative fit testing (QLFT) and quantitative fit testing (QNFT). All testing is to be conducted annually.

1. The test subject shall be allowed to pick the most comfortable respirator from a selection including respirators of various sizes from different manufacturers. The selection shall include at least three sizes of elastomeric facepieces of the type of respirator that is to be tested, i.e., three sizes of half mask; or three sizes of full facepiece. Respirators of each size must be provided from at least two manufacturers.

2. Prior to the selection process, the test subject shall be shown how to put on a respirator, how it should be positioned on the face, how to set strap tension and how to determine a comfortable fit. A mirror shall be available to assist the subject in evaluating the fit and positioning the respirator. This instruction may not constitute the subject's formal training on respirator use; it is only a review.

3. The test subject shall be informed that he/she is being asked to select the respirator which provides the most comfortable fit. Each respirator represents a different size and shape, and if fitted, maintained and

used properly, will provide substantial protection.

4. The test subject shall be instructed to hold each facepiece up to the face and eliminate those which obviously do not give a comfortable fit.

5. The more comfortable facepieces are noted; the most comfortable mask is donned and worn at least five minutes to assess comfort. Assistance in assessing comfort can be given by discussing the points in item 6 below. If the test subject is not familiar with using a particular respirator, the test subject shall be directed to don the mask several times and to adjust the straps each time to become adept at setting proper tension on the straps.

6. Assessment of comfort shall include reviewing the following points with the test subject and allowing the test subject adequate time to determine the comfort of the respirator:

(a) Position of the mask on the nose;

(b) Room for eye protection;

(c) Room to talk; and

(d) Position of mask on face and cheeks.

7. The following criteria shall be used to help determine the adequacy of the respirator fit:

(a) Chin properly placed;

(b) Adequate strap tension, not overly tightened;

(c) Fit across nose bridge;

(d) Respirator of proper size to span distance from nose to chin;

(e) Tendency of respirator to slip; and

(f) Self-observation in mirror to evaluate fit and respirator position.

8. The test subject shall conduct the negative and positive pressure fit checks as described below or in ANSI Z88.2-1980. Before conducting the negative or positive pressure test, the subject shall be told to seat the mask on the face by moving the head from side-to-side and up and down slowly while taking in a few slow deep breaths. Another facepiece shall be selected and retested if the test subject fails the fit check tests.

(a) Positive pressure test. Close off the exhalation valve and exhale gently onto the facepiece. The face fit is considered satisfactory if a slight positive pressure can be built up inside the facepiece without any evidence of outward leakage of air at the seal. For most respirators this method of leak testing requires the wearer to first remove the exhalation valve cover before closing off the exhalation valve and then carefully replacing it after the test.

(b) Negative pressure test. Close off the inlet opening of the canister or cartridge(s) by covering with the palm of the hand(s) or by replacing the filter seal(s). Inhale gently so that the facepiece collapses slightly, and hold the breath for ten seconds. If the facepiece remains in its slightly collapsed condition and no inward leakage of air is detected, the tightness of the respirator is considered satisfactory.

9. The test shall not be conducted if there is any hair growth between the skin and the facepiece sealing surface, such as stubble beard growth, beard, or long sideburns which cross the respirator sealing surface. Any type of apparel which interferes with a satisfactory fit shall be altered or removed.

10. If a test subject exhibits difficulty in breathing during the tests, she or he shall be referred to a physician trained in respiratory disease or pulmonary medicine to determine, in accordance with paragraph (l)(2) and (3) of this standard, whether the test subject can wear a respirator while performing her or his duties.

11. The test subject shall be given the opportunity to wear the successfully fitted respirator for a period of two weeks. If at any time during this period the respirator becomes uncomfortable, the test subject shall be given the opportunity to select a different facepiece and to be retested.

12. The employer shall maintain a record of the fit test administered to an employee. The record shall contain at least the following information:

(a) Name of employee;

(b) Type of respirator;

(c) Brand, size of respirator;

(d) Date of test; and

(e) Where QNFT is used, the fit factor and strip chart recording or other recording of the results of the test. The record shall be maintained until the next fit test is administered.

13. Exercise regimen. Prior to the commencement of the fit test, the test subject shall be given a description of the fit test and the test subject's responsibilities during the test procedure. The description of the process shall include a description of the test exercises that the subject will be performing. The respirator to be tested shall be worn for at least 5 minutes before the start of the fit test.

14. Test Exercises. The test subject shall perform exercises, in the test environment, in the manner described below:

(a) Normal breathing. In a normal standing position, without talking, the subject shall breathe normally.

(b) Deep breathing. In a normal standing position, without talking, the subject shall breathe slowly and deeply, taking care so as to not hyperventilate.

(c) Turning head side to side. Standing in place, the subject shall slowly turn his/her head from side to side between the extreme positions on each side. The head shall be held at each extreme momentarily so the subject can inhale at each side.

(d) Moving head up and down. Standing in place, the subject shall slowly move his/her head up and down. The subject shall be instructed to inhale in the up position (i.e., when looking toward the ceiling).

(e) Talking. The subject shall talk out loud slowly and loud enough so as to be heard clearly by the test conductor. The subject can read from a prepared text such as the Rainbow Passage, count backward from 100, or recite a memorized poem or song.

(f) Grimace. The test subject shall grimace by smiling or frowning.

(g) Bending over. The test subject shall bend at the waist as if he/she were to touch his/her toes. Jogging in place shall be substituted for this exercise in those test environments such as shroud type QNFT units which prohibit bending at the waist.

(h) Normal breathing. Same as exercise 1. Each test exercise shall be performed for one minute except for the grimace exercise which shall be performed for 15 seconds. The test subject shall be questioned by the test conductor regarding the comfort of the respirator upon completion of the protocol. If it has become uncomfortable, another model of respirator shall be tried.

B. Qualitative Fit Test (QLFT) Protocols

1. General.

(a) The employer shall assign specific individuals who shall assume full responsibility for implementing the respirator qualitative fit test program.

(b) The employer shall assure that persons administering QLFTs are able to prepare test solutions, calibrate equipment and perform tests properly, recognize invalid tests, and assure that test equipment is in proper working order.

(c) The employer shall assure that QLFT equipment is kept clean and well maintained so as to operate within the parameters for which it was designed.

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2. Isoamyl Acetate Protocol.

(a) Odor threshold screening. The odor threshold screening test, performed without wearing a respirator, is intended to determine if the individual tested can detect the odor of isoamyl acetate.

(1) Three 1-liter glass jars with metal lids are required.

(2) Odor free water (e.g. distilled or spring water) at approximately 25 degrees C shall be used for the solutions.

(3) The isoamyl acetate (IAA) (also known as isopentyl acetate) stock solution is prepared by adding 1 cc of pure IAA to 800 cc of odor free water in a 1 liter jar and shaking for 30 seconds. A new solution shall be prepared at least weekly.

(4) The screening test shall be conducted in a room separate from the room used for actual fit testing. The two rooms shall be well ventilated and shall not be connected to the same recirculating ventilation system.

(5) The odor test solution is prepared in a second jar by placing 0.4 cc of the stock solution into 500 cc of odor free water using a clean dropper or pipette. The solution shall be shaken for 30 seconds and allowed to stand for two to three minutes so that the IAA concentration above the liquid may reach equilibrium. This solution shall be used for only one day.

(6) A test blank shall be prepared in a third jar by adding 500 cc of odor free water.

(7) The odor test and test blank jars shall be labeled 1 and 2 for jar identification. Labels shall be placed on the lids so they can be periodically peeled, dried off and switched to maintain the integrity of the test.

(8) The following instruction shall be typed on a card and placed on the table in front of the two test jars (i.e., 1 and 2): "The purpose of this test is to determine if you can smell banana oil at a low concentration. The two bottles in front of you contain water. One of these bottles also contains a small amount of banana oil. Be sure the covers are on tight, then shake each bottle for two seconds. Unscrew the lid of each bottle, one at a time, and sniff at the mouth of the bottle. Indicate to the test conductor which bottle contains banana oil."

(9) The mixtures used in the IAA odor detection test shall be prepared in an area separate from where the test is performed, in order to prevent olfactory fatigue in the subject.

(10) If the test subject is unable to correctly identify the jar containing the odor test solution, the IAA qualitative fit test shall not be performed.

(11) If the test subject correctly identifies the jar containing the odor test solution, the test subject may proceed to respirator selection and fit testing.

(b) Isoamyl acetate fit test

(1) The fit test chamber shall be similar to a clear 55-gallon drum liner suspended inverted over a 2-foot diameter frame so that the top of the chamber is about 6 inches above the test subject's head. The inside top center of the chamber shall have a small hook attached.

(2) Each respirator used for the fitting and fit testing shall be equipped with organic vapor cartridges or offer protection against organic vapors. The cartridges or masks shall be changed at least weekly.

(3) After selecting, donning, and properly adjusting a respirator, the test subject shall wear it to the fit testing room. This room shall be separate from the room used for odor threshold screening and respirator selection, and shall be well ventilated, as by an exhaust fan or lab hood, to prevent general room contamination.

(4) A copy of the test exercises and any prepared text from which the subject is to read shall be taped to the inside of the test chamber.

(5) Upon entering the test chamber, the test subject shall be given a 6-inch by 5-inch piece of paper towel, or other porous, absorbent, single-ply material, folded in half and wetted with 0.75 cc of pure IAA. The test subject shall hang the wet towel on the hook at the top of the chamber.

(6) Allow two minutes for the IAA test concentration to stabilize before starting the fit test exercises. This would be an appropriate time to talk with the test subject; to explain the fit test, the importance of his/her cooperation, and the purpose for the head exercises; and to demonstrate some of the exercises.

(7) If at any time during the test, the subject detects the banana like odor of IAA, the respirator fit is inadequate. The subject shall quickly exit from the test chamber and leave the test area to avoid olfactory fatigue.

(8) If the respirator fit was inadequate, the subject shall return to the selection room and remove the respirator, repeat the odor sensitivity test, select and put on another respirator, return to the test chamber and again begin the procedure described in paragraph (I)(B)(2)(b) (1) through (7) of this Appendix. The process continues until a respirator that fits well has been found. Should the odor sensitivity test be failed, the subject shall wait about 5 minutes before retesting. Odor sensitivity will usually have returned by this time.

(9) When a respirator is found that passes the test, its efficiency shall be demonstrated for the subject by having the subject break the face seal and take a breath before exiting the chamber.

(10) When the test subject leaves the chamber, the subject shall remove the saturated towel and return it to the person conducting the test. To keep the test area from becoming contaminated, the used towels shall be kept in a self sealing bag so there is no significant IAA concentration build-up in the test chamber during subsequent tests.

3. Irritant Fume Protocol.

(a) The respirator to be tested shall be equipped with high- efficiency particulate air (HEPA) filters.

(b) The test subject shall be allowed to smell a weak concentration of the irritant smoke before the respirator is donned to become familiar with its characteristic odor.

(c) Break both ends of a ventilation smoke tube containing stannic oxychloride, such as the MSA part No. 5645, or equivalent. Attach one end of the smoke tube to a low flow air pump set to deliver 200 milliliters per minute.

(d) Advise the test subject that the smoke can be irritating to the eyes and instruct the subject to keep his/her eyes closed while the test is performed.

(e) The test conductor shall direct the stream of irritant smoke from the smoke tube towards the face seal area of the test subject. He/she shall begin at least 12 inches from the facepiece and gradually move to within one inch, moving around the whole perimeter of the mask.

(f) The exercises identified in section I. A. 14 above shall be performed by the test subject while the respirator seal is being challenged by the smoke.

(g) Each test subject passing the smoke test without evidence of a response shall be given a sensitivity check of the smoke from the same tube once the respirator has been removed to determine whether he/she reacts to the smoke. Failure to evoke a response shall void the fit test.

(h) The fit test shall be performed in a location with exhaust ventilation sufficient to prevent general contamination of the testing area by the test agent.

4. *Sacchrin Solution Aerosol Protocol*

[Item 4 added by 58 FR 21780, April 23, 1993]

The entire screening and testing procedure shall be explained to the test subject prior to the conduct of the screening test.

(a) Taste threshold screening. The saccharin taste threshold screening, performed without wearing a respirator, is intended to determine whether the individual being tested can detect the taste of saccharin.

(1) Threshold screening as well as fit testing subjects shall wear an enclosure about the head and shoulders that is approximately 12 inches in diameter by 14 inches tall with at least the front portion clear and that allows free movements of the head when a respirator is worn. An enclosure substantially similar to the 3M hood assembly, parts ± FT14 and ± FT15 combined, is adequate.

(2) The test enclosure shall have a ¾-inch hole in front of the test subject's nose and mouth area to accommodate the nebulizer nozzle.

(3) The test subject shall don the test enclosure. Throughout the threshold screening test, the test subject shall breathe through his/her wide open mouth with tongue extended.

(4) Using a Devilbiss Model 40 Inhalation Medication Nebulizer the test conductor shall spray the threshold check solution into the enclosure. This nebulizer shall be clearly marked to distinguish it from the fit test solution nebulizer.

(5) The threshold check solution consists of 0.83 grams of sodium saccharin USP in 1 cc of warm water. It can be prepared by putting 1 cc of the fit test solution (see (b)(5) below) in 100 cc of distilled water.

(6) To produce the aerosol, the nebulizer bulb is firmly squeezed so that it collapses completely, then released and allowed to fully expand.

(7) Ten squeezes are repeated rapidly and then the test subject is asked whether the saccharin can be tasted.

(8) If the first response is negative, ten more squeezes are repeated rapidly and the test subject is again asked whether the saccharin is tasted.

(9) If the second response is negative, ten more squeezes are repeated rapidly and the test subject is again asked whether the saccharin is tasted.

(10) The test conductor will take note of the number of squeezes required to solicit a taste response.

(11) If the saccharin is not tasted after 30 squeezes (step 10), the test subject may not perform the saccharin fit test.

(12) If a taste response is elicited, the test subject shall be asked to take note of the taste for reference in the fit test.

(13) Correct use of the nebulizer means that approximately 1 cc of liquid is used at a time in the nebulizer body.

(14) The nebulizer shall be thoroughly rinsed in water, shaken dry, and refilled at least each morning and afternoon or at least every four hours.

(b) Saccharin solution aerosol fit test procedure.

(1) The test subject may not eat, drink (except plain water), or chew gum for 15 minutes before the test.

(2) The fit test uses the same enclosure described in (a) above.

(3) The test subject shall don the enclosure while wearing the respirator selected in section(a) above. The respirator shall be properly adjusted and equipped with a particulate filter(s).

(4) A second DeVilbiss Model 40 Inhalation Medication Nebulizer is used to spray the fit test solution into the enclosure. This nebulizer shall be clearly marked to distinguish it from the screening test solution nebulizer.

(5) The fit test solution is prepared by adding 83 grams of sodium saccharin to 100 cc of warm water.

(6) As before, the test subject shall breathe through the open mouth with tongue extended.

(7) The nebulizer is inserted into the hole in the front of the enclosure and the fit test solution is sprayed into the enclosure using the same number of squeezes required to elicit a taste response in the screening test.

(8) After generating the aerosol the test subject shall be instructed to perform the exercises in section I.A. 14 above.

(9) Every 30 seconds the aerosol concentration shall be replenished using one half the number of squeezes as initially.

(10) The test subject shall indicate to the test conductor if at any time during the fit test the taste of saccharin is detected.

(11) If the taste of saccharin is detected, the fit is deemed unsatisfactory and a different respirator shall be tried.

C. Quantitative Fit Test (QNFT) Protocol

1. General

(a) The employer shall assign specific individuals who shall assume full responsibility for implementing the respirator quantitative fit test program.

(b) The employer shall ensure that persons administering QNFT are able to calibrate equipment and perform tests properly, recognize invalid tests, calculate fit factors properly and assure that test equipment is in proper working order.

(c) The employer shall assure that QNFT equipment is kept clean and well maintained so as to operate at the parameters for which it was designed.

2. Definitions

(a) Quantitative fit test. The test is performed in a test chamber. The normal air-purifying element of the respirator is replaced by a high-efficiency particulate air (HEPA) filter in the case of particulate QNFT aerosols or a sorbent offering contaminant penetration protection equivalent to high-efficiency filters where the QNFT test agent is a gas or vapor.

(b) Challenge agent means the aerosol, gas or vapor introduced into a test chamber so that its concentration inside and outside the respirator may be measured.

(c) Test subject means the person wearing the respirator for quantitative fit testing.

(d) Normal standing position means standing erect and straight with arms down along the sides and looking straight ahead.

(e) Maximum peak penetration method means the method of determining test agent penetration in the respirator as determined by strip chart recordings of the test. The highest peak penetration for a given exercise is taken to be representative of average penetration into the respirator for that exercise.

(f) Average peak penetration method means the method of determining test agent penetration into the respirator utilizing a strip chart recorder, integrator, or computer. The agent penetration is determined by an average of the peak heights on the graph or by computer integration, for each exercise except the grimace exercise. Integrators or computers which calculate the actual test agent penetration into the respirator for each exercise will also be considered to meet the requirements of the average peak penetration method.

(g) "Fit Factor" means the ration of challenge agent concentration outside with respect to the inside of a respirator inlet covering (facepiece or enclosure).

3. Apparatus

(a) Instrumentation. Aerosol generation, dilution, and measurement systems using corn oil or sodium chloride as test aerosols shall be used for quantitative fit testing.

(b) Test chamber. The test chamber shall be large enough to permit all test subjects to

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perform freely all required exercises without disturbing the challenge agent concentration or the measurement apparatus. The test chamber shall be equipped and constructed so that the challenge agent is effectively isolated from the ambient air, yet uniform in concentration throughout the chamber.

(c) When testing air-purifying respirators, the normal filter or cartridge element shall be replaced with a high-efficiency particulate filter supplied by the same manufacturer.

(d) The sampling instrument shall be selected so that a strip chart record may be made of the test showing the rise and fall of the challenge agent concentration with each inspiration and expiration at fit factors of at least 2,000. Integrators or computers which integrate the amount of test agent penetration leakage into the respirator for each exercise may be used provided a record of the readings is made.

(e) The combination of substitute air-purifying elements, challenge agent and challenge agent concentration in the test chamber shall be such that the test subject is not exposed in excess of an established exposure limit for the challenge agent at any time during the testing process.

(f) The sampling port on the test specimen respirator shall be placed and constructed so that no leakage occurs around the port (e.g. where the respirator is probed), a free air flow is allowed into the sampling line at all times and so that there is no interference with the fit or performance of the respirator.

(g) The test chamber and test set up shall permit the person administering the test to observe the test subject inside the chamber during the test.

(h) The equipment generating the challenge atmosphere shall maintain the concentration of challenge agent inside the test chamber constant to within a 10-percent variation for the duration of the test.

(i) The time lag (interval between an event and the recording of the event on the strip chart or computer or integrator) shall be kept to a minimum. There shall be a clear association between the occurrence of an event inside the test chamber and its being recorded.

(j) The sampling line tubing for the test chamber atmosphere and for the respirator sampling port shall be of equal diameter and of the same material. The length of the two lines shall be equal.

(k) The exhaust flow from the test chamber shall pass through a high-efficiency filter before release.

(l) When sodium chloride aerosol is used, the relative humidity inside the test chamber shall not exceed 50 percent.

(m) The limitations of instrument detection shall be taken into account when determining the fit factor.

(n) Test respirators shall be maintained in proper working order and inspected for deficiencies such as cracks, missing valves and gaskets, etc.

4. Procedural Requirements

(a) When performing the initial positive or negative pressure test the sampling line shall be crimped closed in order to avoid air pressure leakage during either of these tests.

(b) An abbreviated screening isoamyl acetate test or irritant fume test may be utilized in order to quickly identify poor fitting respirators which passed the positive and/or negative pressure test and thus reduce the amount of QNFT time. When performing a screening isoamyl acetate test, combination high- efficiency organic vapor cartridges/canisters shall be used.

(c) A reasonably stable challenge agent concentration shall be measured in the test chamber prior to testing. For canopy or shower curtain type of test units the determination of the challenge agent stability may be established after the test subject has entered the test environment.

(d) Immediately after the subject enters the test chamber, the challenge agent concentration inside the respirator shall be measured to ensure that the peak penetration does not exceed 5 percent for a half mask or 1 percent for a full facepiece respirator.

(e) A stable challenge concentration shall be obtained prior to the actual start of testing.

(f) Respirator restraining straps shall not be overtightened for testing. The straps shall be adjusted by the wearer without assistance from other persons to give a reasonable comfortable fit typical of normal use.

(g) The test shall be terminated whenever any single peak penetration exceeds 5 percent for half masks and 1 percent for full facepiece respirators. The test subject shall be refitted and retested. If two of the three required tests are terminated, the fit shall be deemed inadequate.

(h) In order to successfully complete a QNFT, three successful fit tests are required. The results of each of the three independent fit tests must exceed the minimum fit factor needed for the class of respirator (e.g. half mask respirator, full facepiece respirator).

(i) Calculation of fit factors.

(1) The fit factor shall be determined for the quantitative fit test by taking the ratio of the average chamber concentration to the concentration inside the respirator.

(2) The average test chamber concentration is the arithmetic average of the test chamber concentration at the beginning and at the end of the test.

(3) The concentration of the challenge agent inside the respirator shall be determined by one of the following methods:

(i) Average peak concentration;

(ii) Maximum peak concentration;

(iii) Integration by calculation of the area under the individual peak for each exercise. This includes computerized integration.

(j) Interpretation of test results. The fit factor established by the quantitative fit testing shall be the lowest of the three fit factor values calculated from the three required fit tests.

(k) The test subject shall not be permitted to wear a half mask, or full facepiece respirator unless a minimum fit factor equivalent to at least 10 times the hazardous exposure level is obtained.

(l) Filters used for quantitative fit testing shall be replaced at least weekly, or whenever increased breathing resistance is encountered, or when the test agent has altered the integrity of the filter media. Organic vapor cartridges/canisters shall be replaced daily (when used) or sooner if there is any indication of breakthrough by a test agent.

Appendix D to Section 1910.1027 — Occupational Health History Interview With Reference to Cadmium Exposure

Directions

(To be read by employee and signed prior to the interview)

Please answer the questions you will be asked as completely and carefully as you can. These questions are asked of everyone who works with cadmium. You will also be asked to give blood and urine samples. The doctor will give your employer a written opinion on whether you are physically capable of working with cadmium. Legally, the doctor cannot share personal information you may tell him/her with your employer. The following information is considered strictly confidential. The results of the tests will go to you, your doctor and your employer. You will also receive an information sheet explaining the results of any biological monitoring or physical examinations performed.

If you are just being hired, the results of this interview and examination will be used to:

(1) Establish your health status and see if working with cadmium might be expected to cause unusual problems,

(2) Determine your health status today and see if there are changes over time,

(3) See if you can wear a respirator safely.

If you are not a new hire:

OSHA says that everyone who works with cadmium can have periodic medical examinations performed by a doctor. The reasons for this are:

(a) If there are changes in your health, either because of cadmium or some other reason, to find them early,

(b) to prevent kidney damage.

Please sign below.

I have read these directions and understand them:

_____

Employee signature

_____

Date

Thank you for answering these questions.

(Suggested Format)

Name _____

Age _____

Social Security # _____

Company _____

Job _____

Type of Preplacement Exam:

[ ] Periodic
[ ] Termination
[ ] Initial
[ ] Other

Blood Pressure _____

Pulse Rate _____

1. How long have you worked at the job listed above?
   [ ] Not yet hired
   [ ] Number of months
   [ ] Number of years
2. Job Duties etc.

_____

_____

_____

3. Have you *ever* been told by a doctor that you had bronchitis?
   [ ] Yes
   [ ] No
   If yes, how long ago?
   [ ] Number of months
   [ ] Number of years
4. Have you *ever* been told by a doctor that you had emphysema?
   [ ] Yes
   [ ] No
   If yes, how long ago?
   [ ] Number of years
   [ ] Number of months
5. Have you *ever* been told by a doctor that you had other lung problems?
   [ ] Yes
   [ ] No
   If yes, please describe type of lung problems and when you had these problems: _____

_____

_____

6. In the past year, have you had a cough?
   [ ] Yes
   [ ] No
   If yes, did you cough up sputum?
   [ ] Yes
   [ ] No
   If yes, how long did the cough with sputum production last?
   [ ] Less than 3 months
   [ ] 3 months or longer
   If yes, for how many years have you had episodes of cough with sputum production lasting this long?
   [ ] Less than one
   [ ] 1
   [ ] 2
   [ ] Longer than 2
7. Have you *ever* smoked cigarettes?
   [ ] Yes
   [ ] No
8. Do you now smoke cigarettes?
   [ ] Yes
   [ ] No
9. If you smoke or have smoked cigarettes, for how many years have you smoked, or did you smoke?
   [ ] Less than 1 year
   [ ] Number of years
   What is or was the greatest number of packs per day that you have smoked?
   [ ] Number of packs
   If you quit smoking cigarettes, how many years ago did you quit?
   [ ] Less than 1 year
   [ ] Number of years
   How many packs a day do you now smoke?
   [ ] Number of packs per day
10. Have you *ever* been told by a doctor that you had a kidney or urinary tract disease or disorder?
    [ ] Yes
    [ ] No
11. Have you *ever* had any of these disorders?

Kidney stones ..... [ ] Yes [ ] No
Protein in urine ..... [ ] Yes [ ] No
Blood in urine ..... [ ] Yes [ ] No
Difficulty urinating ..... [ ] Yes [ ] No
Other kidney/Urinary disorders ..... [ ] Yes [ ] No

Please describe problems, age, treatment, and follow up for any kidney or urinary problems you have had: _____

_____

_____

_____

12. Have you *ever* been told by a doctor or other health care provider who took your blood pressure that your blood pressure was high?
    [ ] Yes
    [ ] No
13. Have you *ever* been advised to take any blood pressure medication?
    [ ] Yes
    [ ] No
14. Are you presently taking any blood pressure medication?
    [ ] Yes
    [ ] No
15. Are you presently taking any other medication?
    [ ] Yes
    [ ] No
16. Please list any blood pressure or other medications and describe how long you have been taking each one:

Medicine: _____

_____

_____

_____

How Long Taken

_____

_____

17. Have you *ever* been told by a doctor that you have diabetes? (sugar in your blood or urine)
    [ ] Yes
    [ ] No
    If yes, do you presently see a doctor about your diabetes?
    [ ] Yes
    [ ] No
    If yes, how do you control your blood sugar?

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[ ] Diet alone
[ ] Diet plus oral medicine
[ ] Diet plus insulin (injection)

18. Have you *ever* been told by a doctor that you had:

Anemia . . . . . [ ] Yes [ ] No
A low blood count? . . . . . [ ] Yes [ ] No

19. Do you presently feel that you tire or run out of energy sooner than normal or sooner than other people your age?
[ ] Yes
[ ] No
If yes, for how long have you felt that you tire easily?
[ ] Less than 1 year
[ ] Number of years

20. Have you given blood within the last year?
[ ] Yes
[ ] No
If yes, how many times?
[ ] Number of times
How long ago was the last time you gave blood?
[ ] Less than 1 month
[ ] Number of months

21. Within the last year have you had any injuries with heavy bleeding?
[ ] Yes
[ ] No
If yes, how long ago?
[ ] Less than 1 month
[ ] Number of months
Describe: _____

22. Have you recently had any surgery?
[ ] Yes
[ ] No
If yes, please describe: _____

23. Have you seen any blood lately in your stool or after a bowel movement?
[ ] Yes
[ ] No

24. Have you *ever* had a test for blood in your stool?
[ ] Yes
[ ] No
If yes, did the test show any blood in the stool?
[ ] Yes
[ ] No
What further evaluation and treatment were done?

The following questions pertain to the ability to wear a respirator. Additional information for the physician can be found in The Respiratory Protective Devices Manual.

25. Have you *ever* been told by a doctor that you have asthma?
[ ] Yes
[ ] No
If yes, are you presently taking any medication for asthma? Mark all that apply.
[ ] Shots
[ ] Pills
[ ] Inhaler

26. Have you *ever* had a heart attack?
[ ] Yes
[ ] No
If yes, how long ago?
[ ] Number of years
[ ] Number of months

27. Have you ever had pains in your chest?
[ ] Yes
[ ] No
If yes, when did it usually happen?
[ ] While resting
[ ] While working
[ ] While exercising
[ ] Activity didn't matter

28. Have you *ever* had a thyroid problem?
[ ] Yes
[ ] No

29. Have you ever had a seizure or fits?
[ ] Yes
[ ] No

30. Have you ever had a stroke (cerebrovascular accident)?
[ ] Yes
[ ] No

31. Have you ever had a ruptured eardrum or a serious hearing problem?
[ ] Yes
[ ] No

32. Do you now have a claustrophobia, meaning fear of crowded or closed in spaces or any psychological problems that would make it hard for you to wear a respirator?
[ ] Yes
[ ] No

The following questions pertain to reproductive history.

33. Have you or your partner had a problem conceiving a child?
[ ] Yes
[ ] No
If yes, specify:
[ ] Self
[ ] Present mate
[ ] Previous mate

34. Have you or your partner consulted a physician for a fertility or other reproductive problem?
[ ] Yes
[ ] No
If yes, specify who consulted the physician:
[ ] Self
[ ] Spouse/partner
[ ] Self and partner
If yes, specify diagnosis made: _____

35. Have you or your partner ever conceived a child resulting in a miscarriage, still birth or deformed offspring?
[ ] Yes
[ ] No
If yes, specify: _____
[ ] Miscarriage
[ ] Still birth
[ ] Deformed offspring
If outcome was a deformed offspring, please specify type: _____

36. Was this outcome a result of a pregnancy of:
[ ] Yours with present partner
[ ] Yours with a previous partner

37. Did the timing of any abnormal pregnancy outcome coincide with present employment?
[ ] Yes
[ ] No
List dates of occurrences: _____

38. What is the occupation of your spouse or partner?

For Women Only

39. Do you have menstrual periods?
[ ] Yes
[ ] No
Have you had menstrual irregularities?
[ ] Yes
[ ] No
If yes, specify type: _____
If yes, what was the approximated date this problem began? _____
Approximate date problem stopped? _____

For Men Only

40. Have you *ever* been diagnosed by a physician as having prostate gland problem(s)?
[ ] Yes
[ ] No
If yes, please describe type of problem(s) and what was done to evaluate and treat the problem(s): _____

Appendix E to Section 1910.1027 — Cadmium in Workplace Atmospheres

Method Number: ID-189

Matrix: Air

OSHA Permissible Exposure Limits: 5 μg/m³ (TWA), 2.5 μg/m³ (Action Level TWA)

Collection Procedure: A known volume of air is draw through a 37-mm diameter filter cassette containing a 0.8-μm mixed cellulose ester membrane filter (MCEF).

Recommended Air Volume: 960 L

Recommended Sampling Rate: 2.0 L/min

Analytical Procedure: Air filter samples are digested with nitric acid. After digestion, a small amount of hydrochloric acid is added. The samples are then diluted to volume with deionized water and analyzed by either flame atomic absorption spectroscopy using a heated graphite furnace atomizer (AAS-HGA).

Detection Limits:

Qualitative: 0.2 μg/m³ for a 200 L sample by Flame AAS, 0.007 μg/m³ for a 60 L sample by AAS-HGA

Quantitative: 0.70 μg/m³ for a 200 L sample by Flame AAS, 0.025 μg/m3 for a 60 L sample by AAS-HGA

Precision and Accuracy: (Flame AAS Analysis and AAS-HGA Analysis): Validation Level: 2.5 to 10 μg/m³ for a 400 L air vol, 1.25 to 5.0 μg/m³ for a 60 L air vol

CV_1 (pooled): 0.010, 0.043

Analytical Bias: +4.0%, −5.8%

Overall Analytical Error: ±6.0%, ±14.2%

Method Classification: Validated

Date: June, 1992

Inorganic Service Branch II, OSHA Salt Lake Technical Center, Salt Lake City, Utah

Commercial manufacturers and products mentioned in this method are for descriptive use only and do not constitute endorsements by USDOL-OSHA. Similar products from other sources can be substituted.

1. Introduction

1.1. Scope

This method describes the collection of airborne elemental cadmium and cadmium compounds on 0.8-μm mixed cellulose ester membrane filters and their subsequent analysis by either flame atomic absorption spectroscopy (AAS) or flameless atomic absorption spectroscopy using a heated graphite furnace atomizer (AAS-HGA). It is applicable for both TWA and Action Level TWA Permissible Exposure Level (PEL) measurements. The two atomic absorption analytical techniques included in the method do not differentiate between cadmium fume and cadmium dust samples. They also do not differentiate between elemental cadmium and its compounds.

1.2. Principle

Airborne elemental cadmium and cadmium compounds are collected on a 0.8-μm mixed cellulose ester membrane filter (MCEF). The air filter samples are digested with concentrated nitric acid to destroy the organic matrix and dissolve the cadmium analytes. After digestion, a small amount of concentrated hydrochloric acid is added to help dissolve other metals which may be present. The samples are diluted to volume with deionized water and then aspirated into the oxidizing air/acetylene flame of an atomic absorption spectrophotometer for analysis of elemental cadmium.

If the concentration of cadmium in a sample solution is too low for quantitation by this flame AAS analytical technique, and the sample is to be averaged with other samples for TWA calculations, aliquots of the sample and a matrix modifier are later injected onto a L'vov platform in a pyrolytically-coated graphite tube of a Zeeman atomic absorption spectrophotometer/graphite furnace assembly for analysis of elemental cadmium. The matrix modifier is added to stabilize the cadmium metal and minimize sodium chloride as an interference during the high temperature charring step of the analysis (5.1, 5.2).

1.3. History

Previously, two OSHA sampling and analytical methods for cadmium were used concurrently (5.3, 5.4). Both of these methods also required 0.8-μm mixed cellulose ester membrane filters for the collection of air samples. These cadmium air filter samples were analyzed by either flame atomic absorption spectroscopy (5.3) or inductively coupled plasma/atomic emission spectroscopy (ICP-AES) (5.4). Neither of these two analytical methods have adequate sensitivity for measuring workplace exposure to airborne cadmium at the new lower TWA and Action Level TWA PEL levels when consecutive samples are taken on one employee and the sample results need to be averaged with other samples to determine a single TWA.

The inclusion of two atomic absorption analytical techniques in the new sampling and analysis method for airborne cadmium permits quantitation of sample results over a broad range of exposure levels and sampling periods. The flame AAS analytical technique included in this method is similar to the previous procedure given in the General Metals Method ID-121 (5.3) with some modifications. The sensitivity of the AAS-HGA analytical technique included in this method is adequate to measure exposure levels at 1/10 the Action Level TWA, or lower, when less than full-shift samples need to be averaged together.

1.4. Properties (5.5)

Elemental cadmium is a silver-white, blue-tinged, lustrous metal which is easily cut with a knife. It is slowly oxidized by moist air to form cadmium oxide. It is insoluble in water, but reacts readily with dilute nitric acid. Some of the physical properties and other descriptive information of elemental cadmium are given below:

CAS No	7440-43-9
Atomic Number	48
Atomic Symbol	Cd
Atomic Weight	112.41
Melting Point	321 °C
Boiling Point	765 °C
Density	8.65 g/mL (25 °C)

The properties of specific cadmium compounds are described in reference 5.5.

1.5. Method Performance

A synopsis of method performance is presented below. Further information can be found in Section 4.

1.5.1. The qualitative and quantitative detection limits for the flame AAS analytical technique are 0.04 μg (0.004 μg/mL) and 0.14 μg (0.014 μg/mL) cadmium, respectively, for a 10 mL solution volume. These correspond, respectively, to 0.2 μg/m³ and 0.70 μg/m³ for a 200 L air volume.

1.5.2. The qualitative and quantitative detection limits for the AAS-HGA analytical technique are 0.44 ng (0.044 ng/mL) and 1.5 ng (0.15 ng/mL) cadmium, respectively, for a 10 mL solution volume.

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These correspond, respectively, to 0.007 $\mu g/m^3$ and 0.025 $\mu g/m^3$ for a 60 L air volume.

1.5.3. The average recovery by the flame AAS analytical technique of 17 spiked MCEF samples containing cadmium in the range of 0.5 to 2.0 times the TWA target concentration of 5 $\mu g/m^3$ (assuming a 400 L air volume) was 104.0% with a pooled coefficient of variation (CV_1) of 0.010. The flame analytical technique exhibited a positive bias of +4.0% for the validated concentration range. The overall analytical error (OAE) for the flame AAS analytical technique was ±6.0%.

1.5.4. The average recovery by the AAS-HGA analytical technique of 18 spiked MCEF samples containing cadmium in the range of 0.5 to 2.0 times the Action Level TWA target concentration of 2.5 $\mu g/m^3$ (assuming a 60 L air volume) was 94.2% with a pooled coefficient of variation (CV_1) of 0.043. The AAS-HGA analytical technique exhibited a negative bias of −5.8% for the validated concentration range. The overall analytical error (OAE) for the AAS-HGA analytical technique was ±4.2%.

1.5.5. Sensitivity in flame atomic absorption is defined as the characteristic concentration of an element required to produce a signal of 1% absorbance (0.0044 absorbance units). Sensitivity values are listed for each element by the atomic absorption spectrophotometer manufacturer and have proved to be a very valuable diagnostic tool to determine if instrumental parameters are optimized and if the instrument is performing up to specification. The sensitivity of the spectrophotometer used in the validation of the flame AAS analytical technique agreed with the manufacturer specifications (5.6); the 2 $\mu g/mL$ cadmium standard gave an absorbance reading of 0.350 abs. units.

1.5.6. Sensitivity in graphite furnace atomic absorption is defined in terms of the characteristic mass, the number of picograms required to give an integrated absorbance value of 0.0044 absorbance-second (5.7). Data suggests that under Stabilized Temperature Platform Furnace (STPF) conditions (see Section 1.6.2.), characteristic mass values are transferable between properly functioning instruments to an accuracy of about 20% (5.2). The characteristic mass for STPF analysis of cadmium with Zeeman background correction listed by the manufacturer of the instrument used in the validation of the AAS-HGA analytical technique was 0.35 pg. The experimental characteristic mass value observed during the determination of the working range and detection limits of the AAS-HGA analytical technique was 0.41 pg.

1.6 Interferences

1.6.1. High concentrations of silicate interfere in determining cadmium by flame AAS (5.6). However, silicates are not significantly soluble in the acid matrix used to prepare the samples.

1.6.2. Interferences, such as background absorption, are reduced to a minimum in the AAS-HGA analytical technique by taking full advantage of the Stabilized Temperature Platform Furnace (STPF) concept. STPF includes all of the following parameters (5.2):

a. Integrated Absorbance,

b. Fast Instrument Electronics and Sampling Frequency,

c. Background Correction,

d. Maximum Power Heating,

e. Atomization off the L'vov platform in a pyrolytically coated graphite tube,

f. Gas Stop during Atomization,

g. Use of Matrix Modifiers.

1.7 Toxicology (5.14)

Information listed within this section is synopsis of current knowledge of the physiological effects of cadmium and is not intended to be used as the basis for OSHA policy. IARC classifies cadmium and certain of its compounds as Group 2A carcinogens (probably carcinogenic to humans). Cadmium fume is intensely irritating to the respiratory tract. Workplace exposure to cadmium can cause both chronic and acute effects. Acute effects include tracheobronchitis, pneumonitis, and pulmonary edema. Chronic effects include anemia, rhinitis/anosmia, pulmonary emphysema, proteinuria and lung cancer. The primary target organs for chronic disease are the kidneys (noncarcinogenic) and the lungs (carcinogenic).

2. Sampling

2.1. Apparatus

2.1.1. Filter cassette unit for air sampling: A 37-mm diameter mixed cellulose ester membrane filter with a pore size of 0.8- m̆ contained in a 37-mm polystyrene two- or three-piece cassette filter holder (part no. MAWP 037 A0, Millipore Corp., Bedford, MA). The filter is supported with a cellulose backup pad. The cassette is sealed prior to use with a shrinkable gel band.

2.1.2. A calibrated personal sampling pump whose flow is determined to an accuracy of ±5% at the recommended flow rate with the filter cassette unit in line.

2.2. Procedure

2.2.1. Attach the prepared cassette to the calibrated sampling pump (the backup pad should face the pump) using flexible tubing. Place the sampling device on the employee such that air is sampled from the breathing zone.

2.2.2. Collect air samples at a flow rate of 2.0 L/min. If the filter does not become overloaded, a full-shift (at least seven hours) sample is strongly recommended for TWA and Action Level TWA measurements with a maximum air volume of 960 L. If overloading occurs, collect consecutive air samples for shorter sampling periods to cover the full workshift.

2.2.3. Replace the end plugs into the filter cassettes immediately after sampling. Record the sampling conditions.

2.2.4. Securely wrap each sample filter cassette end-to-end with an OSHA Form 21 sample seal.

2.2.5. Submit at least one blank sample with each set of air samples. The blank sample should be handled the same as the other samples except that no air is drawn through it.

2.2.6. Ship the samples to the laboratory for analysis as soon as possible in a suitable container designed to prevent damage in transit.

3. Analysis

3.1. Safety Precautions

3.1.1. Wear safety glasses, protective clothing and gloves at all times.

3.1.2. Handle acid solutions with care. Handle all cadmium samples and solutions with extra care (see Sect. 1.7.). Avoid their direct contact with work area surfaces, eyes, skin and clothes. Flush acid solutions which contact the skin or eyes with copious amounts of water.

3.1.3. Perform all acid digestions and acid dilutions in an exhaust hood while wearing a face shield. To avoid exposure to acid vapors, do not remove beakers containing concentrated acid solutions from the exhaust hood until they have

returned to room temperature and have been diluted or emptied.

3.1.4. Exercise care when using laboratory glassware. Do not use chipped pipets, volumetric flasks, beakers or any glassware with sharp edges exposed in order to avoid the possibility of cuts or abrasions.

3.1.5. Never pipet by mouth.

3.1.6. Refer to the instrument instruction manuals and SOPs (5.8, 5.9) for proper and safe operation of the atomic absorption spectrophotometer, graphite furnace atomizer and associated equipment.

3.1.7. Because metallic elements and other toxic substances are vaporized during AAS flame or graphite furnace atomizer operation, it is imperative that an exhaust vent be used. Always ensure that the exhaust system is operating properly during instrument use.

3.2. Apparatus for Sample and Standard Preparation

3.2.1. Hot plate, capable of reaching 150 °C, installed in an exhaust hood.

3.2.2. Phillips beakers, 125 mL.

3.2.3. Bottles, narrow-mouth, polyethylene or glass with leakproof caps: used for storage of standards and matrix modifier.

3.2.4. Volumetric flasks, volumetric pipets, beakers and other associated general laboratory glassware.

3.2.5. Forceps and other associated general laboratory equipment.

3.3. Apparatus for Flame AAS Analysis

3.3.1. Atomic absorption spectrophotometer consisting of a(an):

Nebulizer and burner head.

Pressure regulating devices capable of maintaining constant oxidant and fuel pressures.

Optical system capable of isolating the desired wavelength of radiation (228.8 nm)

Adjustable slit

Light measuring and amplifying device

Display, strip chart, or computer interface for indicating the amount of absorbed radiation

Cadmium hollow cathode lamp or electrodeless discharge lamp (EDL) and power supply.

3.3.2. Oxidant: compressed air, filtered to remove water, oil and other foreign substances.

3.3.3. Fuel: standard commercially available tanks of acetylene dissolved in acetone; tanks should be equipped with flash arresters.

Caution: Do not use grades of acetylene containing solvents other than acetone because they may damage the PVC tubing used in some instruments.

3.3.4. Pressure-reducing valves: two gauge, two-stage pressure regulators to maintain fuel and oxidant pressures somewhat higher than the controlled operating pressures of the instrument.

3.3.5. Exhaust vent installed directly above the spectrophotometer burner head.

3.4 Apparatus for AAS-HGA Analysis

3.4.1 Atomic absorption spectrophotometer consisting of a(an):

Heated graphite furnace atomizer (HGA) with argon purge system

Pressure-regulating devices capable of maintaining constant argon purge pressure

Optical system capable of isolating the desired wavelength of radiation (228.8 nm)

Adjustable slit

Light measuring and amplifying device

Display, strip chart, or computer interface for indicating the amount of absorbed radiation (as integrated absorbance, peak area)

Background corrector: Zeeman or deuterium arc. The Zeeman background corrector is recommended

Cadmium hollow cathode lamp or electrodeless discharge lamp (EDL) and power supply

Autosampler capable of accurately injecting 5 to 20 µL sample aliquots onto the L'vov Platform in a graphite tube

3.4.2 Pyrolytically coated graphite tubes containing solid, pyrolytic L'vov platforms.

3.4.3 Polyethylene sample cups, 2.0 to 2.5 mL, for use with the autosampler.

3.4.4 Inert purge gas for graphite furnace atomizer: compressed gas cylinder of purified argon.

3.4.5 Two gauge, two-stage pressure regulator for the argon gas cylinder.

3.4.6 Cooling water supply for graphite furnace atomizer.

3.4.7 Exhaust vent installed directly above the graphite furnace atomizer.

3.5 Reagents.

All reagents should be ACS analytical reagent grade or better.

3.5.1 Deionized water with a specific conductance of less than 10 µS.

3.5.2 Concentrated nitric acid, HNO_3.

3.5.3 Concentrated hydrochloric acid, HCl.

3.5.4 Ammonium phosphate, monobasic, $NH_4H_2PO_4$.

3.5.5 Magnesium nitrate, $Mg(NO_3)_2$.

3.5.6 Diluting solution (4% HNO_3, 0.4% HCl): Add 40 mL HNO_3 and 4 mL HCl carefully to approximately 500 mL deionized water and dilute to 1 L with deionized water.

3.5.7 Cadmium standard stock solution, 1,000 µg/mL: Use a commercially available certified 1,000 µg/mL cadmium standard or, alternatively, dissolve 1.0000 g of cadmium metal in a minimum volume of 1:1 HCl and dilute to 1 L with 4% HNO_3. Observe expiration dates of commercial standards. Properly dispose of commercial standards with no expiration dates or prepared standards one year after their receipt or preparation date.

3.5.8 Matrix modifier for AAS-HGA analysis: Dissolve 1.0 g $NH_4H_2PO_4$ and 0.15 g $Mg(NO_3)_2 6H_2O$ in approximately 200 mL deionized water. Add 1 mL HNO_3 and dilute to 500 mL with deionized water.

3.5.9 Nitric Acid, 1:1 HNO_3/DI H_2O mixture: Carefully add a measured volume of concentrated HNO_3 to an equal volume of DI H_2O.

3.5.10 Nitric acid, 10% v/v: Carefully add 100 mL of concentrated HNO_3 to 500 mL of DI H_2O and dilute to 1 L.

3.6 Glassware Preparation.

3.6.1 Clean Phillips beakers by refluxing with 1:1 nitric acid on a hot plate in a fume hood. Thoroughly rinse with deionized water and invert the beakers to allow them to drain dry.

3.6.2 Rinse volumetric flasks and all other glassware with 10% nitric acid and deionized water prior to use.

3.7 Standard Preparation for Flame AAS Analysis.

3.7.1 Dilute stock solutions: Prepare 1, 5, 10 and 100 µg/mL cadmium standard stock solutions by making appropriate serial dilutions of 1,000 µg/mL cadmium standard stock solution with the diluting solution described in Section 3.5.6

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3.7.2 Working standards: Prepare cadmium working standards in the range of 0.02 to 2.0 μg/mL by making appropriate serial dilutions of the dilute stock solutions with the same diluting solution. A suggested method of preparation of the working standards is given below.

Working standard (μg/mL)	Std solution (μg/mL)	Aliquot (mL)	Final vol. (mL)
0.02	1	10	500
0.05	5	5	500
0.1	10	5	500
0.2	10	10	500
0.5	10	25	500
1	100	5	500
2	100	10	500

Store the working standards in 500-mL, narrow-mouth polyethylene or glass bottles with leak proof caps. Prepare every twelve months.

3.8 Standard Preparation for AAS-HGA Analysis.

3.8.1 Dilute stock solutions: Prepare 10, 100 and 1,000 ng/mL cadmium standard stock solutions by making appropriate ten-fold serial dilutions of the 1,000 ğ/mL cadmium standard stock solution with the diluting solution described in Section 3.5.6.

3.8.2 Working standards: Prepare cadmium working standards in the range of 0.2 to 20 ng/mL by making appropriate serial dilutions of the dilute stock solutions with the same diluting solution. A suggested method of preparation of the working standards is given below.

Working standard (μg/mL)	Std solution (μg/mL)	Aliquot (mL)	Final vol (mL)
0.2	10	2	100
0.5	10	5	100
1	10	10	100
2	100	2	100
5	100	5	100
10	100	10	100
20	1,000	2	100

Store the working standards in narrow-mouth polyethylene or glass bottles with leakproof caps. Prepare monthly.

3.9 Sample Preparation.

3.9.1 Carefully transfer each sample filter with forceps from its filter cassette unit to a clean, separate 125-mL Phillips beaker along with any loose dust found in the cassette. Label each Phillips beaker with the appropriate sample number.

3.9.2 Digest the sample by adding 5 mL of concentrated nitric acid (HNO_3) to each Phillips beaker containing an air filter sample. Place the Phillips beakers on a hot plate in an exhaust hood and heat the samples until approximately 0.5 mL remains. The sample solution in each Phillips beaker should become clear. If it is not clear, digest the sample with another portion of concentrated nitric acid.

3.9.3 After completing the HNO_3 digestion and cooling the samples, add 40 μL (2 drops) of concentrated HCl to each air sample solution and then swirl the contents. Carefully add about 5 mL of deionized water by pouring it down the inside of each beaker.

3.9.4 Quantitatively transfer each cooled air sample solution from each Phillips beaker to a clean 10-mL volumetric flask. Dilute each flask to volume with deionized water and mix well.

3.10 Flame AAS Analysis.

Analyze all of the air samples for their cadmium content by flame atomic absorption spectroscopy (AAS) according to the instructions given below.

3.10.1 Set up the atomic absorption spectrophotometer for the air/acetylene flame analysis of cadmium according to the SOP (5.8.) or the manufacturer's operational instructions. For the source lamp, use the cadmium hollow cathode or electrodeless discharge lamp operated at the manufacturer's recommended rating for continuous operation. Allow the lamp to warm up 10 to 20 min or until the energy output stabilizes. Optimize conditions such as lamp position, burner head alignment, fuel and oxidant flow rates, etc. See the SOP or specific instrument manuals for details. Instrumental parameters for the Perkin-Elmer Model 603 used in the validation of this method are given in Attachment 1.

3.10.2 Aspirate and measure the absorbance of a standard solution of cadmium. The standard concentration should be within the linear range. For the instrumentation used in the validation of this method a 2 μg/mL cadmium standard gives a net absorbance reading of about 0.350 abs. units (see Section 1.5.5.) when the instrument and the source lamp are performing to manufacturer specifications.

3.10.3 To increase instrument response, scale expand the absorbance reading of the aspirated 2 μg/mL working standard approximately four times. Increase the integration time to at least 3 seconds to reduce signal noise.

3.10.4 Autozero the instrument while aspirating a deionized water blank. Monitor the variation in the baseline absorbance reading (baseline noise) for a few minutes to insure that the instrument, source lamp and associated equipment are in good operating condition.

3.10.5 Aspirate the working standards and samples directly into the flame and record their absorbance readings. Aspirate the deionized water blank immediately after every standard or sample to correct for and monitor any baseline drift and noise. Record the baseline absorbance reading of each deionized water blank. Label each standard and sample reading and its accompanying baseline reading.

3.10.6 It is recommended that the entire series of working standards be analyzed at the beginning and end of the analysis of a set of samples to establish a concentration-response curve, ensure that the standard readings agree with each other and are reproducible. Also, analyze a working standard after every five or six samples to monitor the performance of the spectrophotometer. Standard readings should agree within ±10 to 15% of the readings obtained at the beginning of the analysis.

3.10.7 Bracket the sample readings with standards during the analysis. If the absorbance reading of a sample is above the absorbance reading of the highest working standard, dilute the sample with diluting solution and reanalyze. Use the appropriate dilution factor in the calculations.

3.10.8 Repeat the analysis of approximately 10% of the samples for a check of precision.

3.10.9 If possible, analyze quality control samples from an independent source as a check on analytical recovery and precision.

3.10.10 Record the final instrument settings at the end of the analysis. Date and label the output.

3.11 AAS-HGA Analysis.

Initially analyze all of the air samples for their cadmium content by flame atomic absorption spectroscopy (AAS) according to the instructions given in Section 3.10 If the concentration of cadmium in a sample solution is less than three times the quantitative detection limit [0.04 μg/mL (40 ng/mL) for the instrumentation used in the validation] and the

sample results are to be averaged with other samples for TWA calculations, proceed with the AAS-HGA analysis of the sample as described below.

3.11.1 Set up the atomic absorption spectrophotometer and HGA for flameless atomic absorption analysis of cadmium according to the SOP (5.9.) or the manufacturer's operational instructions and allow the instrument to stabilize. The graphite furnace atomizer is equipped with a pyrolytically coated graphite tube containing a pyrolytic platform. For the source lamp, use a cadmium hollow cathode or electrodeless discharge lamp operated at the manufacturer's recommended setting for graphite furnace operation. The Zeeman background corrector and EDL are recommended for use with the L'vov platform. Instrumental parameters for the Perkin-Elmer Model 5100 spectrophotometer and Zeeman HGA- 600 graphite furnace used in the validation of this method are given in Attachment 2.

3.11.2 Optimize the energy reading of the spectrophotometer at 228.8 nm by adjusting the lamp position and the wavelength according to the manufacturer's instructions.

3.11.3 Set up the autosampler to inject a 5-μL aliquot of the working standard, sample or reagent blank solution onto the L'vov platform along with a 10-μL overlay of the matrix modifier.

3.11.4 Analyze the reagent blank (diluting solution, Section 3.5.6) and then autozero the instrument before starting the analysis of a set of samples. It is recommended that the reagent blank be analyzed several times during the analysis to assure the integrated absorbance (peak area) reading remains at or near zero.

3.11.5 Analyze a working standard approximately midway in the linear portion of the working standard range two or three times to check for reproducibility and sensitivity (see sections 1.5.5 and 1.5.6.) before starting the analysis of samples. Calculate the experimental characteristic mass value from the average integrated absorbance reading and injection volume of the analyzed working standard. Compare this value to the manufacturer's suggested value as a check of proper instrument operation.

3.11.6 Analyze the reagent blank, working standard, and sample solutions. Record and label the peak area (abs-sec) readings and the peak and background peak profiles on the printer/plotter.

3.11.7 It is recommended the entire series of working standards be analyzed at the beginning and end of the analysis of a set of samples. Establish a concentration-response curve and ensure standard readings agree with each other and are reproducible. Also, analyze a working standard after every five or six samples to monitor the performance of the system. Standard readings should agree within ±15% of the readings obtained at the beginning of the analysis.

3.11.8 Bracket the sample readings with standards during the analysis. If the peak area reading of a sample is above the peak area reading of the highest working standard, dilute the sample with the diluting solution and reanalyze. Use the appropriate dilution factor in the calculations.

3.11.9 Repeat the analysis of approximately 10% of the samples for a check of precision.

3.11.10 If possible, analyze quality control samples from an independent source as a check of analytical recovery and precision.

3.11.11 Record the final instrument settings at the end of the analysis. Date and label the output.

3.12 Calculations.

Note: Standards used for HGA analysis are in ng/mL. Total amounts of cadmium from calculations will be in ng (not μg) unless a prior conversion is made.

3.12.1 Correct for baseline drift and noise in flame AAS analysis by subtracting each baseline absorbance reading from its corresponding working standard or sample absorbance reading to obtain the net absorbance reading for each standard and sample.

3.12.2 Use a least squares regression program to plot a concentration-response curve of net absorbance reading (or peak area for HGA analysis) versus concentration (μg/mL or ng/mL) of cadmium in each working standard.

3.12.3 Determine the concentration (μg/mL or ng/mL) of cadmium in each sample from the resulting concentration-response curve. If the concentration of cadmium in a sample solution is less than three times the quantitative detection limit [0.04 μg/mL (40 ng/mL) for the instrumentation used in the validation of the method] and if consecutive samples were taken on one employee and the sample results are to be averaged with other samples to determine a single TWA, reanalyze the sample by AAS-HGA as described in Section 3.11. and report the AAS-HGA analytical results.

3.12.4 Calculate the total amount (μg or ng) of cadmium in each sample from the sample solution volume (mL):

W = (C)(sample vol, mL)(DF)

Where:

W = Total cadmium in sample

C = Calculated concentration of cadmium

DF = Dilution Factor (if applicable).

3.12.5 Make a blank correction for each air sample by subtracting the total amount of cadmium in the corresponding blank sample from the total amount of cadmium in the sample.

3.12.6 Calculate the concentration of cadmium in an air sample (mg/m^3 or $\mu g/m^3$) by using one of the following equations:

$mg/m^3 = W_{bc}/(\text{Air vol sampled, L})$

or

$\mu g/m^3 = (W_{bc})(1{,}000\ ng/\mu g)/(\text{Air vol sampled, L})$

Where:

W_{bc} = blank corrected total μg cadmium in the sample. (1μg = 1,000 ng)

4. Backup Data

4.1 Introduction

4.1.1 The purpose of this evaluation is to determine the analytical method recovery, working standard range, and qualitative and quantitative detection limits of the two atomic absorption analytical techniques included in this method. The evaluation consisted of the following experiments:

1. An analysis of 24 samples (six samples each at 0.1, 0.5, 1 and 2 times the TWA-PEL) for the analytical method recovery study of the flame AAS analytical technique.

2. An analysis of 18 samples (six samples each at 0.5, 1 and 2 times the Action Level TWA-PEL) for the analytical method recovery study of the AAS-HGA analytical technique.

3. Multiple analyses of the reagent blank and a series of standard solutions to determine the working standard range and the qualitative and quantitative detection limits for both atomic absorption analytical techniques.

4.1.2 The analytical method recovery results at all test levels were calculated from concentration-response curves and statistically examined for outliers at the

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99% confidence level. Possible outliers were determined using the Treatment of Outliers test (5.10.). In addition, the sample results of the two analytical techniques, at 0.5, 1.0 and 2.0 times their target concentrations, were tested for homogeneity of variances also at the 99% confidence level. Homogeneity of the coefficients of variation was determined using the Bartlett's test (5.11.). The overall analytical error (OAE) at the 95% confidence level was calculated using the equation (5.12.):

$$OAE = \pm[Bias + (1.96)(CV_1(pooled))(100\%)]$$

4.1.3 A derivation of the International Union of Pure and Applied Chemistry (IUPAC) detection limit equation (5.13.) was used to determine the qualitative and quantitative detection limits for both atomic absorption analytical techniques:

$$C_{ld} = k(sd)/m \qquad \text{(Equation 1)}$$

Where:

C_{ld} = the smallest reliable detectable concentration an analytical instrument can determine at a given confidence level.

k = 3 for the Qualitative Detection Limit at the 99.86% Confidence Level

= 10 for the Quantitative Detection Limit at the 99.99% Confidence Level

sd = standard deviation of the reagent blank (Rbl) readings.

m = analytical sensitivity or slope as calculated by linear regression.

4.1.4 Collection efficiencies of metallic fume and dust atmospheres on 0.8-µm mixed cellulose ester membrane filters are well documented and have been shown to be excellent (5.11.). Since elemental cadmium and the cadmium component of cadmium compounds are nonvolatile, stability studies of cadmium spiked MCEF samples were not performed.

4.2 Equipment

4.2.1 A Perkin-Elmer (PE) Model 603 spectrophotometer equipped with a manual gas control system, a stainless steel nebulizer, a burner mixing chamber, a flow spoiler and a 10 cm. (one-slot) burner head was used in the experimental validation of the flame AAS analytical technique. A PE cadmium hollow cathode lamp, operated at the manufacturer's recommended current setting for continuous operation (4 mA), was used as the source lamp. Instrument parameters are listed in Attachment 1.

4.2.2 A PE Model 5100 spectrophotometer, Zeeman HGA-600 graphite furnace atomizer and AS-60 HGA autosampler were used in the experimental validation of the AAS-HGA analytical technique. The spectrophotometer was equipped with a PE Series 7700 professional computer and Model PR-310 printer. A PE System 2 cadmium electrodeless discharge lamp, operated at the manufacturer's recommended current setting for modulated operation (170 mA), was used as the source lamp. Instrument parameters are listed in Attachment 2.

4.3 Reagents

4.3.1 J.T. Baker Chem. Co. (Analyzed grade) concentrated nitric acid, 69.0-71.0%, and concentrated hydrochloric acid, 36.5-38.0%, were used to prepare the samples and standards.

4.3.2 Ammonium phosphate, monobasic, $NH_4H_2PO_4$ and magnesium nitrate, $Mg(NO_3)_2 6H_2O$, both manufactured by the Mallinckrodt Chem. Co., were used to prepare the matrix modifier for AAS-HGA analysis.

4.4 Standard Preparation for Flame AAS Analysis

4.4.1 Dilute stock solutions: Prepared 0.01, 0.1, 1, 10 and 100 µg/mL cadmium standard stock solutions by making appropriate serial dilutions of a commercially available 1,000 µg/mL cadmium standard stock solution (RICCA Chemical Co., Lot# A102) with the diluting solution (4% HNO_3, 0.4% HCl).

4.4.2 Analyzed Standards: Prepared cadmium standards in the range of 0.001 to 2.0 µg/mL by pipetting 2 to 10 mL of the appropriate dilute cadmium stock solution into a 100-mL volumetric flask and diluting to volume with the diluting solution. (See Section 3.7.2.)

4.5 Standard Preparation for AAS-HGA Analysis

4.5.1 Dilute stock solutions: Prepared 1, 10, 100 and 1,000 ng/mL cadmium standard stock solutions by making appropriate serial dilutions of a commercially available 1,000 µg/mL cadmium standard stock solution (J.T. Baker Chemical Co., Instra-analyzed, Lot# D22642) with the diluting solution (4% HNO_3, 0.4% HCl).

4.5.2 Analyzed Standards: Prepared cadmium standards in the range of 0.1 to 40 ng/mL by pipetting 2 to 10 mL of the appropriate dilute cadmium stock solution into a 100-mL volumetric flask and diluting to volume with the diluting solution. (See Section 3.8.2.)

4.6 Detection Limits and Standard Working Range for Flame AAS Analysis

4.6.1 Analyzed the reagent blank solution and the entire series of cadmium standards in the range of 0.001 to 2.0 µg/mL three to six times according to the instructions given in Section 3.10. The diluting solution (4% HNO_3, 0.4% HCl) was used as the reagent blank. The integration time on the PE 603 spectrophotometer was set to 3.0 seconds and a four-fold expansion of the absorbance reading of the 2.0 µg/mL cadmium standard was made prior to analysis. The 2.0 µg/mL standard gave a net absorbance reading of 0.350 abs. units prior to expansion in agreement with the manufacturer's specifications (5.6.).

4.6.2 The net absorbance readings of the reagent blank and the low concentration Cd standards from 0.001 to 0.1 µg/mL and the statistical analysis of the results are shown in Table I. The standard deviation, sd, of the six net absorbance readings of the reagent blank is 1.05 abs. units. The slope, m, as calculated by a linear regression plot of the net absorbance readings (shown in Table II) of the 0.02 to 1.0 µg/mL cadmium standards versus their concentration is 772.7 abs. units/(µg/mL).

4.6.3 If these values for sd and the slope, m, are used in Eqn. 1 (Sect. 4.1.3.), the qualitative and quantitative detection limits as determined by the IUPAC Method are:

C_{ld} = (3)(1.05 abs. units)/(772.7 abs. units/(µg/mL))

= 0.0041 µg/mL for the qualitative detection limit.

C_{ld} = (10)(1.05 abs. units)/(772.7 abs. units/µg/mL))

= 0.014 µg/mL for the quantitative detection limit.

The qualitative and quantitative detection limits for the flame AAS analytical technique are 0.041 µg and 0.14 µg cadmium, respectively, for a 10 mL solution volume. These correspond, respectively, to 0.2 µg/m³ and 0.70 µg/m³ for a 200 L air volume.

4.6.4 The recommended Cd standard working range for flame AAS analysis is 0.02 to 2.0 µg/mL. The net absorbance readings of the reagent blank and the recommended working range standards and the statistical analysis of the results are shown in Table II. The standard of lowest concentration in the working range, 0.02 µg/mL, is slightly greater than the calcu-

lated quantitative detection limit, 0.014 μg/mL. The standard of highest concentration in the working range, 2.0 μg/mL, is at the upper end of the linear working range suggested by the manufacturer (5.6.). Although the standard net absorbance readings are not strictly linear at concentrations above 0.5 μg/mL, the deviation from linearity is only about 10% at the upper end of the recommended standard working range. The deviation from linearity is probably caused by the fourfold expansion of the signal suggested in the method. As shown in Table II, the precision of the standard net absorbance readings are excellent throughout the recommended working range; the relative standard deviations of the readings range from 0.009 to 0.064.

4.7 Detection Limits and Standard Working Range for AAS-HGA Analysis

4.7.1 Analyzed the reagent blank solution and the entire series of cadmium standards in the range of 0.1 to 40 ng/mL according to the instructions given in Section 3.11. The diluting solution (4% HNO_3, 0.4% HCl) was used as the reagent blank. A fresh aliquot of the reagent blank and of each standard was used for every analysis. The experimental characteristic mass value was 0.41 pg, calculated from the average peak area (abs- sec) reading of the 5 ng/mL standard which is approximately midway in the linear portion of the working standard range. This agreed within 20% with the characteristic mass value, 0.35 pg, listed by the manufacturer of the instrument (5.2.).

4.7.2 The peak area (abs-sec) readings of the reagent blank and the low concentration Cd standards from 0.1 to 2.0 ng/mL and statistical analysis of the results are shown in Table III. Five of the reagent blank peak area readings were zero and the sixth reading was 1 and was an outlier. The near lack of a blank signal does not satisfy a strict interpretation of the IUPAC method for determining the detection limits. Therefore, the standard deviation of the six peak area readings of the 0.2 ng/mL cadmium standard, 0.75 abs-sec, was used to calculate the detection limits by the IUPAC method. The slope, m, as calculated by a linear regression plot of the peak area (abs-sec) readings (shown in Table IV) of the 0.2 to 10 ng/mL cadmium standards versus their concentration is 51.5 abs-sec/(ng/mL).

4.7.3 If 0.75 abs-sec (sd) and 51.5 abs-sec/(ng/mL) (m) are used in Eqn. 1 (Sect. 4.1.3.), the qualitative and quantitative detection limits as determined by the IUPAC method are:

C_{ld} = (3)(0.75 abs-sec)/(51.5 abs-sec/(ng/mL)

= 0.044 ng/mL for the qualitative detection limit.

C_{ld} = (10)(0.75 abs-sec)/(51.5 abs-sec/(ng/mL)

= 0.15 ng/mL for the quantitative detection limit.

The qualitative and quantitative detection limits for the AAS-HGA analytical technique are 0.44 ng and 1.5 ng cadmium, respectively, for a 10 mL solution volume. These correspond, respectively, to 0.007 μg/m³ and 0.025 μg/m³ for a 60 L air volume.

4.7.4 The peak area (abs-sec) readings of the Cd standards from 0.2 to 40 ng/mL and the statistical analysis of the results are given in Table IV. The recommended standard working range for AAS-HGA analysis is 0.2 to 20 ng/mL. The standard of lowest concentration in the recommended working range is slightly greater than the calculated quantitative detection limit, 0.15 ng/mL. The deviation from linearity of the peak area readings of the 20 ng/mL standard, the highest concentration standard in the recommended working range, is approximately 10%. The deviations from linearity of the peak area readings of the 30 and 40 ng/mL standards are significantly greater than 10%. As shown in Table IV, the precision of the peak area readings are satisfactory throughout the recommended working range; the relative standard deviations of the readings range from 0.025 to 0.083.

4.8 Analytical Method Recovery for Flame AAS Analysis.

4.8.1 Four sets of spiked MCEF samples were prepared by injecting 20 μL of 10, 50, 100 and 200 μg/mL dilute cadmium stock solutions on 37 mm diameter filters (part no. AAWP 037 00, Millipore Corp., Bedford, MA) with a calibrated micropipet. The dilute stock solutions were prepared by making appropriate serial dilutions of a commercially available 1,000 μg/mL cadmium standard stock solution (RICCA Chemical Co., Lot# A102) with the diluting solution (4% HNO_3, 0.4% HCl). Each set contained six samples and a sample blank. The amount of cadmium in the prepared sets were equivalent to 0.1, 0.5, 1.0 and 2.0 times the TWA PEL target concentration of 5 μg/m³ for a 400 L air volume.

4.8.2 The air-dried spiked filters were digested and analyzed for their cadmium content by flame atomic absorption spectroscopy (AAS) following the procedure described in Section 3. The 0.02 to 2.0μg/mL cadmium standards (the suggested working range) were used in the analysis of the spiked filters.

4.8.3 The results of the analysis are given in Table V. One result at 0.5 times the TWA PEL target concentration was an outlier and was excluded from statistical analysis. Experimental justification for rejecting it is that the outlier value was probably due to a spiking error. The coefficients of variation for the three test levels at 0.5 to 2.0 times the TWA PEL target concentration passed the Bartlett's test and were pooled.

4.8.4 The average recovery of the six spiked filter samples at 0.1 times the TWA PEL target concentration was 118.2% with a coefficient of variation (CV1) of 0.128. The average recovery of the spiked filter samples in the range of 0.5 to 2.0 times the TWA target concentration was 104.0% with a pooled coefficient of variation (CV1) of 0.010. Consequently, the analytical bias found in these spiked sample results over the tested concentration range was +4.0% and the OAE was ±6.0%.

4.9 Analytical Method Recovery for AAS-HGA Analysis

4.9.1 Three sets of spiked MCEF samples were prepared by injecting 15μ L of 5, 10 and 20 μg/mL dilute cadmium stock solutions on 37 mm diameter filters (part no. AAWP 037 00, Millipore Corp., Bedford, MA) with a calibrated micropipet. The dilute stock solutions were prepared by making appropriate serial dilutions of a commercially available certified 1,000 μg/mL cadmium standard stock solution (Fisher Chemical Co., Lot# 913438-24) with the diluting solution (4% HNO_3, 0.4% HCl). Each set contained six samples and a sample blank. The amount of cadmium in the prepared sets were equivalent to 0.5, 1 and 2 times the Action Level TWA target concentration of 2.5 μg/m³ for a 60 L air volume.

4.9.2 The air-dried spiked filters were digested and analyzed for their cadmium content by flameless atomic absorption spectroscopy using a heated graphite furnace atomizer following the procedure

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described in Section 3. A five-fold dilution of the spiked filter samples at 2 times the Action Level TWA was made prior to their analysis. The 0.05 to 20 ng/mL cadmium standards were used in the analysis of the spiked filters.

4.9.3 The results of the analysis are given in Table VI. There were no outliers. The coefficients of variation for the three test levels at 0.5 to 2.0 times the Action Level TWA PEL passed the Bartlett's test and were pooled. The average recovery of the spiked filter samples was 94.2% with a pooled coefficient of variation (CV_1) of 0.043. Consequently, the analytical bias was -5.8% and the OAE was $\pm 14.2\%$.

4.10 Conclusions

The experiments performed in this evaluation show the two atomic absorption analytical techniques included in this method to be precise and accurate and have sufficient sensitivity to measure airborne cadmium over a broad range of exposure levels and sampling periods.

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Table I.-Cd Detection Limit Study
[Flame AAS Analysis]

STD (μg/mL)	Absorbance reading at 228.8 nm		Statistical analysis
Reagent blank	5	2	n = 6.
	4	3	mean = 3.50.
	4	3	std dev = 1.05.
			CV = 0.30.
0.001	6	6	n = 6.
	2	4	mean = 5.00.
	6	6	std dev = 1.67.
			CV = 0.335.
0.002	5	7	n = 6.
	7	3	mean = 5.50.
	7	4	std dev = 1.76.
			CV = 0.320.
0.005	7	7	n = 6.
	8	8	mean = 7.33.
	8	6	std dev = 0.817.
			CV = 0.111.
0.010	10	9	n = 6.
	10	13	mean = 10.3.
	10	10	std dev = 1.37.
			CV = 0.133.
0.020	20	23	n = 6.
	20	22	mean = 20.8.
	20	20	std dev = 1.33.
			CV = 0.064.
0.050	42	42	n = 6.
	42	42	mean = 42.5.
	42	45	std dev = 1.22.
			CV = 0.029.
0.10		84	n = 3.
		80	mean = 82.3.
		83	std dev = 2.08.
			CV = 0.025.

Table II.-Cd Standard Working Range Study
[Flame AAS Analysis]

STD (μg/mL)	Absorbance reading at 228.8 nm		Statistical analysis
Reagent blank	5	2	n = 6.
	4	3	mean = 3.50.
	4	3	std dev = 1.05.
			CV = 0.30.
0.020	20	23	n = 6.
	20	22	mean = 20.8
	20	20	std dev = 1.33.
			CV = 0.064.
0.050	42	42	n = 6.
	42	42	mean = 42.5.
	42	45	std dev = 1.22.
			CV = 0.029.
0.10		84	n = 3.
		80	mean = 82.3.
		83	std dev = 2.08.
			CV = 0.025.
0.20		161	n = 3.
		161	mean = 160.0.
		158	std dev = 1.73.
			CV = 0.011.
0.50		391	n = 3.
		389	mean = 391.0.
		393	std dev = 2.00.
			CV = 0.005.
1.00		760	n = 3.
		748	mean = 753.3.
		752	std dev = 6.11.
			CV = 0.008.
2.00		1416	n = 3.
		1426	mean = 1414.3.
		1401	std dev = 1.26.
			CV = 0.009.

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Table III. CD Detection Limit Study
[AAS-HGA Analysis]

STD (ng/mL)	Peak area readings × 10^3 at 228. 8 nm		Statistical analysis
Reagent blank	0	0	n=6
	0	1	mean=0.167
	0	0	std dev=0.41
			CV=2.45
0.1	8	6	n=6
	5	7	mean=7.7
	13	7	std dev=2.8
			CV=0.366
0.2	11	13	n=6
	11	12	mean=11.8
	12	12	std dev=0.75
			CV=0.064
0.5	28	33	n=6
	26	28	mean=28.8
	28	30	std dev=2.4
			CV=0.083
1.0	52	55	n=6
	56	58	mean=54.8
	54	54	std dev=2.0
			CV=0.037
2.0	101	112	n=6
	110	110	mean=108.8
	110	110	std dev=3.9
			CV=0.036

Table IV. CD Standard Working Range Study
[AAS-HGA Analysis]

STD (ng/mL)	Peak area readings × 10^3 at 228.8 nm		Statistical analysis
0.2	11	13	n=6
	11	12	mean=11.8
	12	12	std dev=0.75
			CV=0.064
0.5	28	33	n=6
	26	28	mean=28.8
	28	30	std dev=2.4
			CV=0.083
1.0	52	55	n=6
	56	58	mean=54.8
	54	54	std dev=2.0
			CV=0.037
2.0	101	112	n=6
	110	110	mean=108.8
	110	110	std dev=3.9
			CV=0.036
5.0	247	265	n=6
	268	275	mean=265.5
	259	279	std dev=11.5
			CV=0.044
10.0	495	520	n=6
	523	513	mean=516.7
	516	533	std dev=12.7
			CV=0.025
20.0	950	953	n=6
	951	958	mean=941.8
	949	890	std dev=25.6
			CV=0.027
30.0	1269	1291	n=6
	1303	1307	mean=1293
	1295	1290	std dev=13.3
			CV=0.010
40.0	1505	1567	n=6
	1535	1567	mean=1552
	1566	1572	std dev=26.6
			CV=0.017

Table V. Analytical Method Recovery
[Flame AAS Analysis]

Test level	0.5 ×	Percent rec	μg taken	1.0 ×	Percent rec	μg taken	2.0 ×	Percent rec
μg taken	μg found			μg found			μg found	
1.00	1.0715	107.2	2.00	2.0688	103.4	4.00	4.1504	103.8
1.00	1.0842	108.4	2.00	2.0174	100.9	4.00	4.1108	102.8
1.00	1.0842	108.4	2.00	2.0431	102.2	4.00	4.0581	101.5
1.00	*1.0081	*100.8	2.00	2.0431	102.2	4.00	4.0844	102.1
1.00	1.0715	107.2	2.00	2.0174	100.9	4.00	4.1504	103.8
1.00	1.0842	108.4	2.00	2.0045	100.2	4.00	4.1899	104.7
n=		5			6			6
mean=		107.9			101.6			103.1
std dev=		0.657			1.174			1.199
CV_1=		0.006			0.011			0.012
0.200				0.2509	125.5			
0.200				0.2509	125.5			
0.200				0.2761	138.1			
0.200				0.2258	112.9			
0.200				0.2258	112.9			
0.200				0.1881	94.1			
n=					6			
mean=					118.2			
std dev=					15.1			
CV_1=					0.128			

CV_1 (pooled)=0.010

* Rejected as an outlier—this value did not pass the outlier T-test at the 99% confidence level.

Table VI.-Analytical Method Recovery
[AAS-HGA analysis]

Test level	0.5 ×	Percent rec	ng taken	1.0 ×	Percent rec	ng taken	2.0 ×	Percent rec
ng taken	ng found			ng found			ng found	
75	71.23	95.0	150	138.00	92.0	300	258.43	86.1
75	71.47	95.3	150	138.29	92.2	300	258.46	86.2
75	70.02	93.4	150	136.30	90.9	300	280.55	93.5
75	77.34	103.1	150	146.62	97.7	300	288.34	96.1
75	78.32	104.4	150	145.17	96.8	300	261.74	87.2
75	71.96	95.9	150	144.88	96.6	300	277.22	92.4
n=		6			6			6
mean=		97.9			94.4			90.3
std dev=		4.66			2.98			4.30
CV_1=		0.048			0.032			0.048
				CV_1(pooled)=0.043				

Attachment 1
Instrumental Parameters for Flame AAS Analysis

Atomic Absorption Spectrophotometer (Perkin-Elmer Model 603)
Flame: Air/Acetylene-lean, blue
Oxidant Flow: 55
Fuel Flow: 32
Wavelength: 228.8 nm
Slit: 4 (0.7 nm)
Range: UV
Signal: Concentration (4 exp)
Integration Time: 3 sec

Attachment 2
Instrumental Parameters for HGA Analysis

Atomic Absorption Spectrophotometer (Perkin-Elmer Model 5100)
Signal Type: Zeeman AA
Slitwidth: 0.7 nm
Wavelength: 228.8 nm
Measurement: Peak Area
Integration Time: 6.0 sec
BOC Time: 5 sec
BOC=Background Offset Correction.

Zeeman Graphite Furnace (Perkin-Elmer Model HGA-600)

Step	Ramp time (sec)	Hold time (sec)	Temp. (°C)	Argon flow (mL/min)	Read (sec)
1) Predry	5	10	90	300	
2) Dry	30	10	140	300	
3) Char	10	20	900	300	
4) Cool Down	1	8	30	300	
5) Atomize	0	5	1600	0	-1
6) Burnout	1	8	2500	300	

Appendix F to — — —: Nonmandatory Protocol for Biological Monitoring
1.0 Introduction

Under the final OSHA cadmium rule (29 CFR part 1910), monitoring of biological specimens and several periodic medical examinations are required for eligible employees.

These medical examinations are to be conducted regularly, and medical monitoring is to include the periodic analysis of cadmium in blood (CDB), cadmium in urine (CDU) and beta-2-microglobulin in urine (B_2MU). As CDU and B_2MU are to be normalized to the concentration of creatinine in urine (CRTU), then CRTU must be analyzed in conjunction with CDU and B_2MU analyses.

The purpose of this protocol is to provide procedures for establishing and maintaining the quality of the results obtained from the analyses of CDB, CDU and B_2MU by commercial laboratories. Laboratories conforming to the provisions of this nonmandatory protocol shall be known as "participating laboratories." The biological monitoring data from these laboratories will be evaluated by physicians responsible for biological monitoring to determine the conditions under which employees may continue to work in locations exhibiting airborne-cadmium concentrations at or above defined actions levels (see paragraphs (l)(3) and (l)(4) of the final rule). These results also may be used to support a decision to remove workers from such locations.

Under the medical monitoring program for cadmium, blood and urine samples must be collected at defined intervals from workers by physicians responsible for medical monitoring; these samples are sent to commerical laboratories that perform the required analyses and report results of these analyses to the responsible physicians. To ensure the accuracy and reliability of these laboratory analyses, the laboratories to which samples are submitted should participate in an ongoing and efficacious proficiency testing program. Availability of proficiency testing programs may vary with the analyses performed.

To test proficiency in the analysis of CDB, CDU and B_2MU, a laboratory should participate either in the interlaboratory comparison program operated by the Centre de Toxicologie du Quebec (CTQ) or an equivalent program. (Currently, no laboratory in the U.S. performs proficiency testing on CDB, CDU or B_2MU.) Under this program, CTQ sends participating laboratories 18 samples of each analyte (CDB, CDU and/or B_2MU) annually for analysis. Participating laboratories must return the results of these analyses to CTQ within four to five weeks after receiving the samples.

The CTQ program pools analytical results from many participating laboratories to derive consensus mean values for each of the samples distributed. Results reported by each laboratory then are compared against these consensus means for the analyzed samples to determine the relative performance of each laboratory. The proficiency of a participating laboratory is a function of the extent of agreement between results submitted by the participating laboratory and the consensus values for the set of samples analyzed.

Proficiency testing for CRTU analysis (which should be performed with CDU and B_2MU analyses to evaluate the results properly) also is recommended. In the U.S., only the College of American Pathologists (CAP) currently conducts CRTU proficiency testing; participating laboratories should be accredited for CRTU analysis by the CAP.

Results of the proficiency evaluations will be forwarded to the participating laboratory by the proficiency-testing laboratory, as well as to physicians designated by the participating laboratory to receive this information. In addition, the par-

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ticipating laboratory should, on request, submit the results of their internal Quality Assurance/Quality Control (QA/QC) program for each analytic procedure (i.e., CDB, CDU and/or B_2MU) to physicians designated to receive the proficiency results. For participating laboratories offering CDU and/or B_2MU analyses, QA/QC documentation also should be provided for CRTU analysis. (Laboratories should provide QA/QC information regarding CRTU analysis directly to the requesting physician if they perform the analysis in-house; if CRTU analysis is performed by another laboratory under contract, this information should be provided to the physician by the contract laboratory.)

QA/QC information, along with the actual biological specimen measurements, should be provided to the responsible physician using standard formats. These physicians then may collate the QA/QC information with proficiency test results to compare the relative performance of laboratories, as well as to facilitate evaluation of the worker monitoring data. This information supports discretionary decisions made by the physician with regard to the biological monitoring program, and for mandating medical removal.

This protocol describes procedures that may be used by the responsible physicians to identify laboratories most likely to be proficient in the analysis of samples used in the biological monitoring of cadmium; also provided are procedures for record keeping and reporting by laboratories participating in proficiency testing programs, and recommendations to assist these physicians in interpreting analytical results determined by participating laboratories. As the collection and handling of samples affects the quality of the data, recommendations are made for these tasks. Specifications for analytical methods to be used in the medical monitoring program are included in this protocol as well.

In conclusion, this document is intended as a supplement to characterize and maintain the quality of medical monitoring data collected under the final cadmium rule promulgated by OSHA (29 CFR part 1910). OSHA has been granted authority under the Occupational Safety and Health Act of 1970 to protect workers from the effects of exposure to hazardous substances in the work place and to mandate adequate monitoring of workers to determine when adverse health effects may be occurring. This nonmandatory protocol is intended to provide guidelines and recommendations to improve the accuracy and reliability of the procedures used to analyze the biological samples collected as part of the medical monitoring program for cadmium.

2.0 Definitions.

When the terms below appear in this protocol, use the following definitions.

Accuracy: A measure of the bias of a data set. Bias is a systematic error that is either inherent in a method or caused by some artifact or idiosyncracy of the measurement system. Bias is characterized by a consistent deviation (positive or negative) in the results from an accepted reference value.

Arithmetic Mean: The sum of measurements in a set divided by the number of measurements in a set.

Blind Samples: A quality control procedure in which the concentration of analyte in the samples should be unknown to the analyst at the time that the analysis is performed.

Coefficient of Variation: The ratio of the standard deviation of a set of measurements to the mean (arithmetic or geometric) of the measurements.

Compliance Samples: Samples from exposed workers sent to a participating laboratory for analysis.

Control Charts: Graphic representations of the results for quality control samples being analyzed by a participating laboratory.

Control Limits: Statistical limits which define when an analytic procedure exceeds acceptable parameters; control limits provide a method of assessing the accuracy of analysts, laboratories, and discrete analytic runs.

Control Samples: Quality control samples.

F/T: The measured amount of an analyte divided by the theoretical value (defined below) for that analyte in the sample analyzed; this ratio is a measure of the recovery for a quality control sample.

Geometric Mean: The natural antilog of the mean of a set of natural log-transformed data.

Geometric Standard Deviation: The antilog of the standard deviation of a set of natural log-transformed data.

Limit of Detection: Using a predefined level of confidence, this is the lowest measured value at which some of the measured material is likely to have come from the sample.

Mean: A central tendency of a set of data; in this protocol, this mean is defined as the arithmetic mean (see definition of arithmetic mean above) unless stated otherwise.

Performance: A measure of the overall quality of data reported by a laboratory.

Pools: Groups of quality-control samples to be established for each target value (defined below) of an analyte. For the protocol provided in attachment 3, for example, the theoretical value of the quality control samples of the pool must be within a range defined as plus or minus ($\pm$) 50% of the target value. Within each analyte pool, there must be quality control samples of at least 4 theoretical values.

Precision: The extent of agreement between repeated, independent measurements of the same quantity of an analyte.

Proficiency: The ability to satisfy a specified level of analyte performance.

Proficiency Samples: Specimens, the values of which are unknown to anyone at a participating laboratory, and which are submitted by a participating laboratory for proficiency testing.

Quality or Data Quality: A measure of the confidence in the measurement value.

Quality Control (QC) Samples: Specimens, the value of which is unknown to the analyst, but is known to the appropriate QA/QC personnel of a participating laboratory; when used as part of a laboratory QA/QC program, the theoretical values of these samples should not be known to the analyst until the analyses are complete. QC samples are to be run in sets consisting of one QC sample from each pool (see definition of "pools" above).

Sensitivity: For the purposes of this protocol, the limit of detection.

Standard Deviation: A measure of the distribution or spread of a data set about the mean; the standard deviation is equal to the positive square root of the variance, and is expressed in the same units as the original measurements in the data set.

Standards: Samples with values known by the analyst and used to calibrate equipment and to check calibration throughout an analytic run. In a laboratory QA/QC program, the values of the standards must exceed the values obtained for compliance samples such that the lowest standard value is near the limit of detection and the highest standard is higher than the highest compliance sample or QC sample. Standards of at least three different values are to be used for calibration, and should be constructed from at least 2 different sources.

Target Value: Those values of CDB, CDU or B_2MU which trigger some action as prescribed in the medical surveillance section of the regulatory text of the final cadmium rule. For CDB, the target values are 5, 10 and 15 μg/l. For CDU, the target values are 3, 7 and 15 μg/g CRTU. For B_2MU, the target values are 300, 750 and 1500 μg/g CRTU. (Note that target values may vary as a function of time.)

Theoretical Value (or Theoretical Amount): The reported concentration of a quality-control sample (or calibration standard) derived from prior characterizations of the sample.

Value or Measurement Value: The numerical result of a measurement.

Variance: A measure of the distribution or spread of a data set about the mean; the variance is the sum of the squares of the

differences between the mean and each discrete measurement divided by one less than the number of measurements in the data set.

3.0 Protocol

This protocol provides procedures for characterizing and maintaining the quality of analytic results derived for the medical monitoring program mandated for workers under the final cadmium rule.

3.1 Overview.

The goal of this protocol is to assure that medical monitoring data are of sufficient quality to facilitate proper interpretation. The data quality objectives (DQOs) defined for the medical monitoring program are summarized in Table 1. Based on available information, the DQOs presented in Table 1 should be achievable by the majority of laboratories offering the required analyses commercially; OSHA recommends that only laboratories meeting these DQOs be used for the analysis of biological samples collected for monitoring cadmium exposure.

To satisfy the DQOs presented in Table 1. OSHA provides the following guidelines:

1. Procedures for the collection and handling of blood and urine are specified (Section 3.4.1 of this protocol);

2. Preferred analytic methods for the analysis of CDB, CDU and B_2MU are defined (and a method for the determination of CRTU also is specified since CDU and B_2MU results are to be normalized to the level of CRTU).

3. Procedures are described for identifying laboratories likely to provide the required analyses in an accurate and reliable manner;

4. These guidelines (Sections 3.2.1 to 3.2.3, and Section 3.3) include recommendations regarding internal QA/QC programs for participating laboratories, as well as levels of proficiency through participation in an interlaboratory proficiency program;

5. Procedures for QA/QC record keeping (Section 3.3.2), and for reporting QC/QA results are described (Section 3.3.3); and,

6. Procedures for interpreting medical monitoring results are specified (Section 3.4.3)

Methods recommended for the biological monitoring of eligible workers are:

1. The method of Stoeppler and Brandt (1980) for CDB determinations (limit of detection: 0.5 μg/l);

2. The method of Pruszkowska et al. (1983) for CDU determinations (limit of detection: 0.5 μg/l of urine); and,

3. The Pharmacia Delphia test kit (Pharmacia 1990) for the determination of B_2MU (limit of detection: 100 μg/l urine).

Because both CDU and B_2MU should be reported in μg/g CRTU, an independent determination of CRTU is recommended. Thus, both the OSHA Salt Lake City Technical Center (OSLTC) method (OSHA, no date) and the Jaffe method (Du Pont, no date) for the determination of CRTU are specified under this protocol (i.e., either of these 2 methods may be used). Note that although detection limits are not reported for either of these CRTU methods, the range of measurements expected for CRTU (0.9-1.7 μg/l) are well above the likely limit of detection for either of these methods (Harrison, 1987).

Laboratories using alternate methods should submit sufficient data to the responsible physicians demonstrating that the alternate method is capable of satisfying the defined data quality objectives of the program. Such laboratories also should submit a QA/QC plan that documents the performance of the alternate method in a manner entirely equivalent to the QA/QC plans proposed in Section 3.3.1.

3.2 Duties of the Responsible Physician

The responsible physician will evaluate biological monitoring results provided by participating laboratories to determine whether such laboratories are proficient and have satisfied the QA/QC recommendations. A requirement of the medical monitoring program mandated under the cadmium rule is that responsible physicians have the duty to employ laboratories to perform the required CDB, CDU and B_2MU analyses of biological samples collected from eligible workers (paragraph (l)(1)(iv) of the final rule). In determining which laboratories to employ for this purpose, these physicians should review proficiency and QA/QC data submitted to them by the participating laboratories.

Participating laboratories should demonstrate proficiency for each analyte (CDU, CDB and B_2MU) sampled under the biological monitoring program. Participating laboratories involved in analyzing CDU and B_2MU also should demonstrate proficiency for CRTU analysis, or provide evidence of a contract with a laboratory proficient in CRTU analysis.

3.2.1 Recommendations for Selecting Among Existing Laboratories.

OSHA recommends that existing laboratories providing commercial analyses for CDB, CDU and/or B_2MU for the medical monitoring program satisfy the following criteria:

1. Should have performed commercial analyses for the appropriate analyte (CDB, CDU and/or B_2MU) on a regular basis over the last 2 years;

2. Should provide the responsible physician with an internal QA/QC plan;

3. If performing CDU or B_2MU analyses, the participating laboratory should be accredited by the CAP for CRTU analysis, and should be enrolled in the corresponding CAP survey (note that alternate credentials may be acceptable, but acceptability is to be determined by the responsible physician); and,

4. Should have enrolled in the CTQ interlaboratory comparison program for the appropriate analyte (CDB, CDU and/or B_2MU).

Participating laboratories should submit appropriate documentation demonstrating compliance with the above criteria to the responsible physician. To demonstrate compliance with the first of the above criteria, participating laboratories should submit the following documentation for each analyte they plan to analyze (note that each document should cover a period of at least 8 consecutive quarters, and that the period designated by the term "regular analyses" is at least once a quarter):

1. Copies of laboratory reports providing results from regular analyses of the appropriate analyte (CDB, CDU and/or B_2MU);

2. Copies of 1 or more signed and executed contracts for the provision of regular analyses of the appropriate analyte (CDB, CDU and/or B_2MU); or,

3. Copies of invoices sent to 1 or more clients requesting payment for the provision of regular analyses of the appropriate analyte (CDB, CDU and/or B_2MU).

Whatever the form of documentation submitted, the specific analytic procedures conducted should be identified directly. The forms that are copied for submission to the responsible physician also should identify the laboratory which provided these analyses.

To demonstrate compliance with the second of the above criteria, a laboratory should submit to the responsible physician an internal QA/QC plan detailing the standard operating procedures to be adopted for satisfying the recommended QA/QC procedures for the analysis of each specific analyte (CDB, CDU and/or B_2MU). Procedures for internal QA/QC programs are detailed in Section 3.3.1 below.

To satisfy the third of the above criteria, laboratories analyzing for CDU or B_2MU also should submit a QA/QC plan for creatinine analysis (CRTU); the QA/QC plan and characterization analyses for CRTU must come from the laboratory performing the CRTU analysis, even if the CRTU analysis is being performed by a contract laboratory.

Laboratories enrolling in the CTQ program (to satisfy the last of the above criteria) must remit, with the enrollment application, an initial fee of approximately $100 per analyte. (Note that this

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Table 1. Recommended Data Quality Objectives (DQOs) for the Cadmium Medical Monitoring Program

Analyte/concentration pool	Limit of detection	Precision (CV)(%)	Accuracy
Cadmium in blood	0.5 μg/l		±1 μg/l or 15% of the mean
≤2 μg/l		40	
>2 μg/l		20	
Cadmium in urine	0.5 μg/g creatinine		±1 μg/l or 15% of the mean
≤μg/l creatinine		40	
>μg/l creatinine		20	
β-2-microglobulin in urine: 100 μg/g creatinine	100 μg/g creatinine	5	±15% of the mean

fee is only an estimate, and is subject to revision without notice.) Laboratories should indicate on the application that they agree to have proficiency test results sent by the CTQ directly to the physicians designated by participating laboratories.

Once a laboratory's application is processed by the CTQ, the laboratory will be assigned a code number which will be provided to the laboratory on the initial confirmation form, along with identification of the specific analytes for which the laboratory is participating. Confirmation of participation will be sent by the CTQ to physicians designated by the applicant laboratory.

3.2.2 Recommended Review of Laboratories Selected to Perform Analyses.

Six months after being selected initially to perform analyte determinations, the status of participating laboratories should be reviewed by the responsible physicians. Such reviews should then be repeated every 6 months or whenever additional proficiency or QA/QC documentation is received (whichever occurs first).

As soon as the responsible physician has received the CTQ results from the first 3 rounds of proficiency testing (i.e., 3 sets of 3 samples each for CDB, CDU and/or B_2MU) for a participating laboratory, the status of the laboratory's continued participation should be reviewed. Over the same initial 6-month period, participating laboratories also should provide responsible physicians the results of their internal QA/QC monitoring program used to assess performance for each analyte (CDB, CDU and/or B_2MU) for which the laboratory performs determinations. This information should be submitted using appropriate forms and documentation.

The status of each participating laboratory should be determined for each analyte (i.e., whether the laboratory satisfies minimum proficiency guidelines based on the proficiency samples sent by the CTQ and the results of the laboratory's internal QA/QC program). To maintain competency for analysis of CDB, CDU and/or B_2MU during the first review, the laboratory should satisfy performance requirements for at least 2 of the 3 proficiency samples provided in each of the 3 rounds completed over the 6-month period. Proficiency should be maintained for the analyte(s) for which the laboratory conducts determinations.

To continue participation for CDU and/or B_2MU analyse, laboratories also should either maintain accreditation for CRTU analysis in the CAP program and participate in the CAP surveys, or they should contract the CDU and B_2MU analyses to a laboratory which satisfies these requirements (or which can provide documentation of accreditation/participation in an equivalent program).

The performance requirement for CDB analysis is defined as an analytical result within ±1 μg/l blood or 15% of the consensus mean (whichever is greater). For samples exhibiting a consensus mean less than 1 ğ/l, the performance requirement is defined as a concentration between the detection limit of the analysis and a maximum of 2 μg/l. The purpose for redefining the acceptable interval for low CDB values is to encourage proper reporting of the actual values obtained during measurement; laboratories, therefore, will not be penalized (in terms of a narrow range of acceptability) for reporting measured concentrations smaller than 1 μg/l.

The performance requirement for CDU analysis is defined as an analytical result within ±1 μg/l urine or 15% of the consensus mean (whichever is greater). For samples exhibiting a consensus mean less than 1 μg/l urine, the performance requirement is defined as a concentration between the detection limit of the analysis and a maximum of 2 μg/l urine. Laboratories also should demonstrate proficiency in creatinine analysis as defined by the CAP. Note that reporting CDU results, other than for the CTQ proficiency samples (i.e., compliance samples), should be accompanied with results of analyses for CRTU, and these 2 sets of results should be combined to provide a measure of CDU in units of μg/g CRTU.

The performance requirement for B_2MU is defined as analytical results within ± 15% of the consensus mean. Note that reporting B_2MU results, other than for CTQ proficiency samples (i.e., compliance samples), should be accompanied with results of analyses for CRTU, and these 2 sets of results should be combined to provide a measure of B_2MU in units of μg/g CRTU.

There are no recommended performance checks for CRTU analyses. As stated previously, laboratories performing CRTU analysis in support of CDU or B_2MU analyses should be accredited by the CAP, and participating in the CAP's survey for CRTU.

Following the first review, the status of each participating laboratory should be reevaluated at regular intervals (i.e., corresponding to receipt of results from each succeeding round of proficiency testing and submission of reports from a participating laboratory's internal QA/QC program).

After a year of collecting proficiency test results, the following proficiency criterion should be added to the set of criteria used to determine the participating laboratory's status (for analyzing CDB, CDU and/or B_2MU): A participating laboratory should not fail performance requirements for more than 4 samples from the 6 most recent consecutive rounds used to assess proficiency for CDB, CDU and/or B_2MU separately (i.e., a total of 18 discrete proficiency samples for each analyte). Note that this requirement does not replace, but supplements, the recommendation that a laboratory should satisfy the performance criteria for at least 2 of the 3 samples tested for each round of the program.

3.2.3 Recommendations for Selecting Among Newly-Formed Laboratories (or Laboratories that Previously Failed to Meet the Protocol Guidelines).

OSHA recommends that laboratories that have not previously provided commercial analyses of CDB, CDU and/or B_2MU (or have done so for a period less than 2 years), or which have provided these analyses for 2 or more years but have not conformed previously with these protocol guidelines, should satisfy the following provisions for each analyte for which determinations are to be made prior to being selected to analyze biological samples under the medical monitoring program:

1. Submit to the responsible physician an internal QA/QC plan detailing the standard operating procedures to be adopted for satisfying the QA/QC guidelines (guidelines for internal QA/QC programs are detailed in Section 3.3.1);

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2. Submit to the responsible physician the results of the initial characterization analyses for each analyte for which determinations are to be made;

3. Submit to the responsible physician the results, for the initial 6-month period, of the internal QA/QC program for each analyte for which determinations are to be made (if no commercial analyses have been conducted previously, a minimum of 2 mock standardization trials for each analyte should be completed per month for a 6-month period);

4. Enroll in the CTQ program for the appropriate analyte for which determinations are to be made, and arrange to have the CTQ program submit the initial confirmation of participation and proficiency test results directly to the designated physicians. Note that the designated physician should receive results from 3 completed rounds from the CTQ program before approving a laboratory for participation in the biological monitoring program;

5. Laboratories seeking participation for CDU and/or B_2MU analyses should submit to the responsible physician documentation of accreditation by the CAP for CRTU analyses performed in conjunction with CDU and/or B_2MU determinations (if CRTU analyses are conducted by a contract laboratory, this laboratory should submit proof of CAP accreditation to the responsible physician); and,

6. Documentation should be submitted on an appropriate form.

To participate in CDB, CDU and/or B_2MU analyses, the laboratory should satisfy the above criteria for a minimum of 2 of the 3 proficiency samples provided in each of the 3 rounds of the CTQ program over a 6-month period; this procedure should be completed for each appropriate analyte. Proficiency should be maintained for each analyte to continue participation. Note that laboratories seeking participation for CDU or B_2MU also should address the performance requirements for CRTU, which involves providing evidence of accreditation by the CAP and participation in the CAP surveys (or an equivalent program).

The performance requirement for CDB analysis is defined as an analytical result within ± 1 μg/l or 15% of the consensus mean (whichever is greater). For samples exhibiting a consensus mean less than 1 μg/l, the performance requirement is defined as a concentration between the detection limit of the analysis and a maximum of 2 μg/l. The purpose of redefining the acceptable interval for low CDB values is to encourage proper reporting of the actual values obtained during measurement; laboratories, therefore, will not be penalized (in terms of a narrow range of acceptability) for reporting measured concentrations less than 1 μg/l.

The performance requirement for CDU analysis is defined as an analytical result within ± 1 μg/l urine or 15% of the consensus mean (whichever is greater). For samples exhibiting a consensus mean less than 1 μg/l urine, the performance requirement is defined as a concentration that falls between the detection limit of the analysis and a maximum of 2 μg/l urine. Performance requirements for the companion CRTU analysis (defined by the CAP) also should be met. Note that reporting CDU results, other than for CTQ proficiency testing (i.e., compliance samples), should be accompanied with results of CRTU analyses, and these 2 sets of results should be combined to provide a measure of CDU in units of μg/g CRTU.

The performance requirement for B_2MU is defined as an analytical result within $\pm 15\%$ of the consensus mean. Note that reporting B_2MU results, other than for CTQ proficiency testing (i.e., compliance samples), should be accompanied with results of CRTU analysis, these 2 sets of results should be combined to provide a measure of B_2MU in units of μg/g CRTU.

Once a new laboratory has been approved by the responsible physician for conducting analyte determinations, the status of this approval should be reviewed periodically by the responsible physician as per the criteria presented under Section 3.2.2.

Laboratories which have failed previously to gain approval of the responsible physician for conducting determinations of 1 or more analytes due to lack of compliance with the criteria defined above for existing laboratories (Section 3.2.1), may obtain approval by satisfying the criteria for newly-formed laboratories defined under this section; for these laboratories, the second of the above criteria may be satisfied by submitting a new set of characterization analyses for each analyte for which determinations are to be made.

Reevaluation of these laboratories is discretionary on the part of the responsible physician. Reevaluation, which normally takes about 6 months, may be expedited if the laboratory can achieve 100% compliance with the proficiency test criteria using the 6 samples of each analyte submitted to the CTQ program during the first 2 rounds of proficiency testing.

For laboratories seeking reevaluation for CDU or B_2MU analysis, the guidelines for CRTU analyses also should be satisfied, including accreditation for CRTU analysis by the CAP, and participation in the CAP survey program (or accreditation/participation in an equivalent program).

3.2.4 Future Modifications to the Protocol Guidelines.

As participating laboratories gain experience with analyses for CDB, CDU and B_2MU, it is anticipated that the performance achievable by the majority of laboratories should improve until it approaches that reported by the research groups which developed each method. OSHA, therefore, may choose to recommend stricter performance guidelines in the future as the overall performance of participating laboratories improves.

3.3 Guidelines for Record Keeping and Reporting.

To comply with these guidelines, participating laboratories should satisfy the above-stated performance and proficiency recommendations, as well as the following internal QA/QC, record keeping, and reporting provisions.

If a participating laboratory fails to meet the provisions of these guidelines, it is recommended that the responsible physician disapprove further analyses of biological samples by that laboratory until it demonstrates compliance with these guidelines. On disapproval, biological samples should be sent to a laboratory that can demonstrate compliance with these guidelines, at least until the former laboratory is reevaluated by the responsible physician and found to be in compliance.

The following record keeping and reporting procedures should be practiced by participating laboratories.

3.3.1 Internal Quality Assurance/Quality Control Procedures.

Laboratories participating in the cadmium monitoring program should develop and maintain an internal quality assurance/quality control (QA/QC) program that incorporates procedures for establishing and maintaining control for each of the analytic procedures (determinations of CDB, CDU and/or B_2MU) for which the laboratory is seeking participation. For laboratories analyzing CDU and/or B_2MU, a QA/QC program for CRTU also should be established.

Written documentation of QA/QC procedures should be described in a formal QA/QC plan; this plan should contain the following information: Sample acceptance and handling procedures (i.e., chain-of-custody); sample preparation procedures; instrument parameters; calibration procedures; and, calculations. Documentation of QA/QC procedures should be sufficient to identify analytical problems, define criteria under which analysis of compliance samples will be suspended, and describe procedures for corrective actions.

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3.3.1.1 QA/QC procedures for establishing control of CDB and CDU analyses.

The QA/QC program for CDB and CDU should address, at a minimum, procedures involved in calibration, establishment of control limits, internal QC analyses and maintaining control, and corrective-action protocols. Participating laboratory should develop and maintain procedures to assure that analyses of compliance samples are within control limits, and that these procedures are documented thoroughly in a QA/QC plan.

A nonmandatory QA/QC protocol is presented in Attachment 1. This attachment is illustrative of the procedures that should be addressed in a proper QA/QC program.

Calibration. Before any analytic runs are conducted, the analytic instrument should be calibrated. Calibration should be performed at the beginning of each day on which QC and/or compliance samples are run. Once calibration is established, QC or compliance samples may be run. Regardless of the type of samples run, about every fifth sample should serve as a standard to assure that calibration is being maintained.

Calibration is being maintained if the standard is within ±15% of its theoretical value. If a standard is more than ±15% of its theoretical value, the run has exceeded control limits due to calibration error; the entire set of samples then should be reanalyzed after recalibrating or the results should be recalculated based on a statistical curve derived from that set of standards.

It is essential that the value of the highest standard analyzed be higher than the highest sample analyzed; it may be necessary, therefore, to run a high standard at the end of the run, which has been selected based on results obtained over the course of the run (i.e., higher than any standard analyzed to that point).

Standards should be kept fresh; as samples age, they should be compared with new standards and replaced if necessary.

Internal Quality Control Analyses. Internal QC samples should be determined interspersed with analyses of compliance samples. At a minimum, these samples should be run at a rate of 5% of the compliance samples or at least one set of QC samples per analysis of compliance samples, whichever is greater. If only 2 samples are run, they should contain different levels of cadmium.

Internal QC samples may be obtained as commercially-available reference materials and/or they may be internally prepared. Internally-prepared samples should be well characterized and traced, or compared to a reference material for which a consensus value is available.

Levels of cadmium contained in QC samples should not be known to the analyst prior to reporting the results of the analysis.

Internal QC results should be plotted or charted in a manner which describes sample recovery and laboratory control limits.

Internal Control Limits. The laboratory protocol for evaluating internal QC analyses per control limits should be clearly defined. Limits may be based on statistical methods (e.g., as 2° from the laboratory mean recovery), or on proficiency testing limits (e.g., ±1 μg or 15% of the mean, whichever is greater). Statistical limits that exceed ±40% should be reevaluated to determine the source error in the analysis.

When laboratory limits are exceeded, analytic work should terminate until the source of error is determined and corrected; compliance samples affected by the error should be reanalyzed. In addition, the laboratory protocol should address any unusual trends that develop which may be biasing the results. Numerous, consecutive results above or below laboratory mean recoveries, or outside laboratory statistical limits, indicate that problems may have developed.

Corrective Actions. The QA/QC plan should document in detail specific actions taken if control limits are exceeded or unusual trends develop. Corrective actions should be noted on an appropriate form, accompanied by supporting documentation.

In addition to these actions, laboratories should include whatever additional actions are necessary to assure that accurate data are reported to the responsible physicians.

Reference Materials. The following reference materials may be available: Cadmium in Blood (CDB).

1. Centre de Toxicologie du Quebec, Le Centre Hospitalier de l'Universite Laval, 2705 boul. Laurier, Quebec, Que., Canada G1V 4G2. (Prepared 6 times per year at 1-15 μg Cd/l.).

2. H. Marchandise, Community Bureau of Reference-BCR, Directorate General XII, Commission of the European Communities, 200, rue de la Loi, B-1049, Brussels, Belgium. (Prepared as Bl CBM-1 at 5.37 μg Cd/l, and Bl CBM-2 at 12.38 μg Cd/l.).

3. Kaulson Laboratories Inc., 691 Bloomfield Ave., Caldwell, NJ 07006; tel: (201) 226-9494, FAX (201) 226-3244. (Prepared as #0141 [As, Cd, Hg, Pb] at 2 levels.)

Cadmium in Urine (CDU).

1. Centre de Toxicologie du Quebec, Le Centre Hospitalier de l'Universite Laval, 2705 boul. Laurier, Quebec, Que., Canada G1V 4G2. (Prepared 6 times per year.).

2. National Institute of Standards and Technology (NIST), Dept. of Commerce, Gaithersburg, MD; tel: (301) 975-6776. (Prepared as SRM 2670 freeze-dried urine [metals]; set includes normal and elevated levels of metals; cadmium is certified for elevated level of 88.0 μg/l in reconstituted urine.).

3. Kaulson Laboratories Inc., 691 Bloomfield Ave., Caldwell, NJ 07006; tel: (201) 226-9494, FAX (201) 226-3244. (Prepared as #0140 [As, Cd, Hg, Pb] at 2 levels.)

3.3.1.2 QA/QC procedures for establishing control of B_2MU.

A written, detailed QA/QC plan for B_2MU analysis should be developed. The QA/QC plan should contain a protocol similar to those protocols developed for the CDB/CDU analyses. Differences in analyses may warrant some differences in the QA/QC protocol, but procedures to ensure analytical integrity should be developed and followed.

Examples of performance summaries that can be provided include measurements of accuracy (i.e., the means of measured values versus target values for the control samples) and precision (i.e., based on duplicate analyses). It is recommended that the accuracy and precision measurements be compared to those reported as achievable by the Pharmacia Delphia kit (Pharmacia 1990) to determine if and when unsatisfactory analyses have arisen. If the measurement error of 1 or more of the control samples is more than 15%, the run exceeds control limits. Similarly, this decision is warranted when the average CV for duplicate samples is greater than 5%.

3.3.2 Procedures for Record Keeping.

To satisfy reporting requirements for commercial analyses of CDB, CDU and/or B_2MU performed for the medical monitoring program mandated under the cadmium rule, participating laboratories should maintain the following documentation for each analyte:

1. For each analytic instrument on which analyte determinations are made, records relating to the most recent calibration and QC sample analyses;

2. For these instruments, a tabulated record for each analyte of those determinations found to be within and outside of control limits over the past 2 years;

3. Results for the previous 2 years of the QC sample analyses conducted under the internal QA/QC program (this information should be: Provided for each analyte for which determinations are made and for each analytic instrument used for this purpose, sufficient to demonstrate that internal QA/QC programs are being executed properly, and consistent with data sent to responsible physicians.

4. Duplicate copies of monitoring

results for each analyte sent to clients during the previous 5 years, as well as associated information; supporting material such as chain-of-custody forms also should be retained; and,

5. Proficiency test results and related materials received while participating in the CTQ interlaboratory program over the past 2 years; results also should be tabulated to provide a serial record of relative error (derived per Section 3.3.3 below).

3.3.3 Reporting Procedures.

Participating laboratories should maintain these documents: QA/QC program plans; QA/QC status reports; CTQ proficiency program reports; and, analytical data reports. The information that should be included in these reports is summarized in Table 2; a copy of each report should be sent to the responsible physician.

As noted in Section 3.3.1, a QA/QC program plan should be developed that documents internal QA/QC procedures (defined under Section 3.3.1) to be implemented by the participating laboratory for each analyte; this plan should provide a list identifying each instrument used in making analyte determinations.

A QA/QC status report should be written bimonthly for each analyte. In this report, the results of the QC program during the reporting period should be reported for each analyte in the following manner: The number (N) of QC samples analyzed during the period; a table of the target levels defined for each sample and the corresponding measured values; the mean of F/T value (as defined below) for the set of QC samples run during the period; and, use of $X \pm 2\sigma$ (as defined below) for the set of QC samples run during the period as a measure of precision.

As noted in Section 2, an F/T value for a QC sample is the ratio of the measured concentration of analyte to the established (i.e., reference) concentration of analyte for that QC sample. The equation below describes the derivation of the mean for F/T values, X:

$$\bar{X} = \frac{(F/T)}{N}$$

The standard deviation, σ, for these measurements is derived using the following equation (note that 2σ is twice this value):

$$\sigma = \left[\frac{\Sigma\,(F/T - \bar{X})^2}{n-1}\right]^{1/2}$$

The nonmandatory QA/QC protocol (see Attachment 3) indicates that QC samples should be divided into several discrete pools, and a separate estimate of precision for each pools then should be derived. Several precision estimates should be provided for concentrations which differ in average value. These precision measures may be used to document improvements in performance with regard to the combined pool.

Participating laboratories should use the CTQ proficiency program for each analyte. Results of the this program will be sent by CTQ directly to physicians designated by the participating laboratories. Proficiency results from the CTQ program are used to establish the accuracy of results from each participating laboratory, and should be provided to responsible physicians for use in trend analysis. A proficiency report consisting of these proficiency results should accompany data reports as an attachment.

For each analyte, the proficiency report should include the results from the 6 previous proficiency rounds in the following format:

1. Number (N) of samples analyzed;
2. Mean of the target levels, $(1/N)\Sigma T_i$, with T_i being a consensus mean for the sample;
3. Mean of the measurements, $(1/N)\Sigma M_i$, with M_i being a sample measurement;
4. A measure of error defined by: $(1/N)\Sigma(T_i - M_i)^2$

Analytical data reports should be submitted to responsible physicians directly. For each sample, report the following information: The date the sample was received; the date the sample was analyzed; appropriate chain-of-custody information; the type(s) of analyses performed; and, the results of the analyses. This information should be reported on a form similar to the form provided an appropriate form. The most recent proficiency program report should accompany the analytical data reports (as an attachment).

Confidence intervals for the analytical results should be reported as $X \pm 2\sigma$, with X being the measured value and 2σ the standard deviation calculated as described above.

For CDU or B_2MU results, which are combined with CRTU measurements for proper reporting, the 95% confidence limits are derived from the limits for CDU or B_2MU, (p), and the limits for CRTU, (q), as follows:

$$\frac{X}{\bar{Y}^2} \pm \left(\frac{1}{\bar{Y}^2}\right)(Y^2 \times p^2 + q^2)^{1/2}$$

For these calculations, $X \pm p$ is the measurement and confidence limits for CDU or B_2MU, and $Y \pm q$ is the measurement and confidence limit for CRTU.

Participating laboratories should notify responsible physicians as soon as they receive information indicating a change in their accreditation status with the CTQ or the CAP. These physicians should not be expected to wait until formal notice of a status change has been received from the CTQ or the CAP.

3.4 Instructions to Physicians

Physicians responsible for the medical monitoring of cadmium-exposed workers must collect the biological samples from workers; they then should select laboratories to perform the required analyses, and should interpret the analytic results.

3.4.1 Sample Collection and Holding Procedures

Blood Samples. The following procedures are recommended for the collection, shipment and storage of blood sam-

Table 2.-Reporting Procedures for Laboratories Participating in the Cadmium Medical Monitoring Program

Report	Frequency (time frame)	Contents
1 QA/QC Program Plan	Once (initially)	A detailed description of the QA/QC protocol to be established by the laboratory to maintain control of analyte determinations.
2 QA/QC Status Report	Every 2 months	Results of the QC samples incorporated into regular runs for each instrument (over the period since the last report)
3 Proficiency Report	Attached to every data report	Results from the last full year of proficiency samples submitted to the CTQ program and Results of the 100 most recent QC samples incorporated into regular runs for each instrument.
4 Analytical Data Report	For all reports of data results	Date the sample was received; Date the sample was analyzed; Appropriate chain-of-custody information; Types of analyses performed; Results of the requested analyses and copy of the most current proficiency report.

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ples for CDB analysis to reduce analytical variablility; these recommendations were obtained primarily through personal communications with J.P. Weber of the CTQ (1991), and from reports by the Centers for Disease Control (CDC, 1986) and Stoeppler and Brandt (1980).

To the extent possible, blood samples should be collected from workers at the same time of day. Workers should shower or thoroughly wash their hands and arms before blood samples are drawn. The following materials are needed for blood sample collection: Alcohol wipes; sterile gauze sponges; band-aids; 20-gauge, 1.5-in. stainless steel needles (sterile); preprinted labels; tourniquets; vacutainer holders; 3-ml "metal free" vacutainer tubes (i.e., dark-blue caps), with EDTA as an anti-coagulant; and, styrofoam vacutainer shipping containers.

Whole blood samples are taken by venipuncture. Each blue-capped tube should be labeled or coded for the worker and company before the sample is drawn. (Blue-capped tubes are recommended instead of red-capped tubes because the latter may consist of red coloring pigment containing cadmium, which could contaminate the samples.) Immediately after sampling, the vacutainer tubes must be thoroughly mixed by inverting the tubes at least 10 times manually or mechanically using a Vortex device (for 15 sec). Samples should be refrigerated immediately or stored on ice until they can be packed for shipment to the participating laboratory for analysis.

The CDC recommends that blood samples be shipped with a "cool pak" to keep the samples cold during shipment. However, the CTQ routinely ships and receives blood samples for cadmium analysis that have not been kept cool during shipment. The CTQ has found no deterioration of cadmium in biological fluids that were shipped via parcel post without a cooling agent, even though these deliveries often take 2 weeks to reach their destination.

Urine Samples. The following are recommended procedures for the collection, shipment and storage of urine for CDU and B_2MU analyses, and were obtained primarily through personal communications with J.P. Weber of the CTQ (1991), and from reports by the CDC (1986) and Stoeppler and Brandt (1980).

Single "spot" samples are recommended. As B2M can degrade in the bladder, workers should first empty their bladder and then drink a large glass of water at the start of the visit. Urine samples then should be collected within 1 hour. Separate samples should be collected for CDU and B_2MU using the following materials: Sterile urine collection cups (250 ml); small sealable plastic bags; preprinted labels; 15-ml polypropylene or polyethylene screw-cap tubes; lab gloves ("metal free"); and, preservatives (as indicated).

The sealed collection cup should be kept in the plastic bag until collection time. The workers should wash their hands with soap and water before receiving the collection cup. The collection cup should not be opened until just before voiding and the cup should be sealed immediately after filling. It is important that the inside of the container and cap are not touched by, or come into contact with, the body, clothing or other surfaces.

For CDU analyzes, the cup is swirled gently to resuspend any solids, and the 15-ml tube is filled with 10-12 ml urine. The CDC recommends the addition of 100 μl concentrated HNO_3 as a preservative before sealing the tube and then freezing the sample. The CTQ recommends minimal handling and does not acidify their interlaboratory urine reference materials prior to shipment, nor do they freeze the sample for shipment. At the CTQ, if the urine sample has much sediment, the sample is acidified in the lab to free any cadmium in the precipitate.

For B_2M, the urine sample should be collected directly into a polyethylene bottle previously washed with dilute nitric acid. The pH of the urine should be measured and adjusted to 8.0 with 0.1 N NaOH immediately following collection. Samples should be frozen and stored at -20 °C until testing is performed. The B_2M in the samples should be stable for 2 days when stored at 2-8 °C, and for at least 2 months at − 20 °C. Repeated freezing and thawing should be avoided to prevent denaturing the B2M (Pharmacia 1990).

3.4.2 Recommendations for Evaluating Laboratories.

Using standard error data and the results of proficiency testing obtained from CTQ, responsible physicians can make an informed choice of which laboratory to select to analyze biological samples. In general, laboratories with small standard errors and little disparity between target and measured values tend to make precise and accurate sample determinations. Estimates of precision provided to the physicians with each set of monitoring results can be compared to previously-reported proficiency and precision estimates. The latest precision estimates should be at least as small as the standard error reported previously by the laboratory. Moreover, there should be no indication that precision is deteriorating (i.e., increasing values for the precision estimates). If precision is deteriorating, physicians may decide to use another laboratory for these analyses. QA/QC information provided by the participating laboratories to physicians can, therefore, assist physicians in evaluating laboratory performance.

3.4.3 Use and Interpretation of Results.

When the responsible physician has received the CDB, CDU and/or B_2MU results, these results must be compared to the action levels discussed in the final rule for cadmium. The comparison of the sample results to action levels is straightforward. The measured value reported from the laboratory can be compared directly to the action levels; if the reported value exceeds an action level, the required actions must be initiated.

4.0 Background.

Cadmium is a naturally-occurring environmental contaminant to which humans are continually exposed in food, water, and air. The average daily intake of cadmium by the U.S. population is estimated to be 10-20 μg/day. Most of this intake is via ingestion, for which absorption is estimated at 4-7% (Kowal et al. 1979). An additional nonoccupational source of cadmium is smoking tobacco; smoking a pack of cigarettes a day adds an additional 2-4 μg cadmium to the daily intake, assuming absorption via inhalation of 25-35% (Nordberg and Nordberg 1988; Friberg and Elinder 1988; Travis and Haddock 1980).

Exposure to cadmium fumes and dusts in an occupational setting where air concentrations are 20-50 $\mu g/m_3$ results in an additional daily intake of several hundred micrograms (Friberg and Elinder 1988, p. 563). In such a setting, occupational exposure to cadmium occurs primarily via inhalation, although additional exposure may occur through the ingestion of material via contaminated hands if workers eat or smoke without first washing. Some of the particles that are inhaled initially may be ingested when the material is deposited in the upper respiratory tract, where it may be cleared by mucociliary transport and subsequently swallowed.

Cadmium introduced into the body through inhalation or ingestion is transported by the albumin fraction of the blood plasma to the liver, where it accumulates and is stored principally as a bound form complexed with the protein metallothionein. Metallothionein- bound cadmium is the main form of cadmium subsequently transported to the kidney; it is these 2 organs, the liver and kidney, in which the majority of the cadmium body burden accumulates. As much as one half of the total body burden of cadmium may be found in the kidneys (Nordberg and Nordberg 1988).

Once cadmium has entered the body, elimination is slow; about 0.02% of the body burden is excreted per day via

urinary/fecal elimination. The whole-body half-life of cadmium is 10-35 years, decreasing slightly with increasing age (Travis and Haddock 1980).

The continual accumulation of cadmium is the basis for its chronic noncarcinogenic toxicity. This accumulation makes the kidney the target organ in which cadmium toxicity usually is first observed (Piscator 1964). Renal damage may occur when cadmium levels in the kidney cortex approach 200 μg/g wet tissue-weight (Travis and Haddock 1980).

The kinetics and internal distribution of cadmium in the body are complex, and depend on whether occupational exposure to cadmium is ongoing or has terminated. In general, cadmium in blood is related principally to recent cadmium exposure, while cadmium in urine reflects cumulative exposure (i.e., total body burden) (Lauwerys et al. 1976; Friberg and Elinder 1988).

4.1 Health Effects.

Studies of workers in a variety of industries indicate that chronic exposure to cadmium may be linked to several adverse health effects including kidney dysfunction, reduced pulmonary function, chronic lung disease and cancer (Federal Register 1990). The primary sites for cadmium-associated cancer appear to be the lung and the prostate.

Cancer. Evidence for an association between cancer and cadmium exposure comes from both epidemiological studies and animal experiments. Pott (1965) found a statistically significant elevation in the incidence of prostate cancer among a cohort of cadmium workers. Other epidemiology studies also report an elevated incidence of prostate cancer; however, the increases observed in these other studies were not statistically significant (Meridian Research, Inc. 1989).

One study (Thun et al. 1985) contains sufficiently quantitative estimates of cadmium exposure to allow evaluation of dose-response relationships between cadmium exposure and lung cancer. A statistically significant excess of lung cancer attributed to cadmium exposure was found in this study, even after accounting for confounding variables such as coexposure to arsenic and smoking habits (Meridian Research, Inc. 1989).

Evidence for quantifying a link between lung cancer and cadmium exposure comes from a single study (Takenaka et al. 1983). In this study, dose-response relationships developed from animal data were extrapolated to humans using a variety of models. OSHA chose the multistage risk model for estimating the risk of cancer for humans using these animal data. Animal injection studies also suggest an association between cadmium exposure and cancer, particularly observations of an increased incidence of tumors at sites remote from the point of injection. The International Agency for Research on Cancer (IARC) (Supplement 7, 1987) indicates that this, and related, evidence is sufficient to classify cadmium as an animal carcinogen. However, the results of these injection studies cannot be used to quantify risks attendant to human occupational exposures due to differences in routes of exposure (Meridian Research, Inc. 1989).

Based on the above-cited studies, the U.S. Environmental Protection Agency (EPA) classifies cadmium as "B1," a probable human carcinogen (USEPA 1985). IARC in 1987 recommended that cadmium be listed as a probable human carcinogen.

Kidney Dysfunction. The most prevalent nonmalignant effect observed among workers chronically exposed to cadmium is kidney dysfunction. Initially, such dysfunction is manifested by proteinuria (Meridian Research, Inc. 1989; Roth Associates, Inc. 1989). Proteinuria associated with cadmium exposure is most commonly characterized by excretion of low-molecular weight proteins (15,000-40,000 MW), accompanied by loss of electrolytes, uric acid, calcium, amino acids, and phosphate. Proteins commonly excreted include β-2-microglobulin (B2M), retinol-binding protein (RBP), immunoglobulin light chains, and lysozyme. Excretion of low molecular weight proteins is characteristic of damage to the proximal tubules of the kidney (Iwao et al. 1980).

Exposure to cadmium also may lead to urinary excretion of high-molecular weight proteins such as albumin, immunoglobulin G, and glycoproteins (Meridian Research, Inc. 1989; Roth Associates, Inc. 1989). Excretion of high-molecular weight proteins is indicative of damage to the glomeruli of the kidney. Bernard et al. (1979) suggest that cadmium-associated damage to the glomeruli and damage to the proximal tubules of the kidney develop independently of each other, but may occur in the same individual.

Several studies indicate that the onset of low-molecular weight proteinuria is a sign of irreversible kidney damage (Friberg et al. 1974; Roels et al. 1982; Piscator 1984; Elinder et al. 1985; Smith et al. 1986). For many workers, once sufficiently elevated levels of B2M are observed in association with cadmium exposure, such levels do not appear to return to normal even when cadmium exposure is eliminated by removal of the worker from the cadmium-contaminated work environment (Friberg, exhibit 29, 1990).

Some studies indicate that cadmium-induced proteinuria may be progressive; levels of B_2MU increase even after cadmium exposure has ceased (Elinder et al. 1985). Other researchers have reached similar conclusions (Frieburg testimony, OSHA docket exhibit 29, Elinder testimony, OSHA docket exhibit 55, and OSHA docket exhibits 8-86B). Such observations are not universal, however (Smith et al. 1986; Tsuchiya 1976). Studies in which proteinuria has not been observed, however, may have initiated the reassessment too early (Meridian Research, Inc.1989; Roth Associates, Inc. 1989; Roels 1989).

A quantitative assessment of the risks of developing kidney dysfunction as a result of cadmium exposure was performed using the data from Ellis et al. (1984) and Falck et al. (1983). Meridian Research, Inc. (1989) and Roth Associates, Inc. (1989) employed several mathematical models to evaluate the data from the 2 studies, and the results indicate that cumulative cadmium exposure levels between 5 and 100 μg-years/m3 correspond with a one-in-a-thousand probability of developing kidney dysfunction.

When cadmium exposure continues past the onset of early kidney damage (manifested as proteinuria), chronic nephrotoxicity may occur (Meridian Research, Inc. 1989; Roth Associates, Inc. 1989). Uremia, which is the loss of the glomerulus' ability to adequately filter blood, may result. This condition leads to severe disturbance of electrolyte concentrations, which may result in various clinical complications including atherosclerosis, hypertension, pericarditis, anemia, hemorrhagic tendencies, deficient cellular immunity, bone changes, and other problems. Progression of the disease may require dialysis or a kidney transplant.

Studies in which animals are chronically exposed to cadmium confirm the renal effects observed in humans (Friberg et al. 1986). Animal studies also confirm cadmium-related problems with calcium metabolism and associated skeletal effects, which also have been observed among humans. Other effects commonly reported in chronic animal studies include anemia, changes in liver morphology, immunosuppression and hypertension. Some of these effects may be associated with cofactors; hypertension, for example, appears to be associated with diet, as well as with cadmium exposure. Animals injected with cadmium also have shown testicular necrosis.

4.2 Objectives for Medical Monitoring.

In keeping with the observation that renal disease tends to be the earliest clinical manifestation of cadmium toxicity, the final cadmium standard mandates that eligible workers must be medically

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monitored to prevent this condition (as well as cadmimum-induced cancer). The objectives of medical-monitoring, therefore, are to: Identify workers at significant risk of adverse health effects from excess, chronic exposure to cadmium; prevent future cases of cadmium-induced disease; detect and minimize existing cadmium-induced disease; and, identify workers most in need of medical intervention.

The overall goal of the medical monitoring program is to protect workers who may be exposed continuously to cadmium over a 45-year occupational lifespan. Consistent with this goal, the medical monitoring program should assure that:

1. Current exposure levels remain sufficiently low to prevent the accumulation of cadmium body burdens sufficient to cause disease in the future by monitoring CDB as an indicator of recent cadmium exposure;

2. Cumulative body burdens, especially among workers with undefined historical exposures, remain below levels potentially capable of leading to damage and disease by assessing CDU as an indicator of cumulative exposure to cadmium; and,

3. Health effects are not occurring among exposed workers by determining B_2MU as an early indicator of the onset of cadmium-induced kidney disease.

4.3 Indicators of Cadmium Exposure and Disease.

Cadmium is present in whole blood bound to albumin, in erythrocytes, and as a metallothionein-cadmium complex. The metallothionein- cadmium complex that represents the primary transport mechanism for cadmium delivery to the kidney. CDB concentrations in the general, nonexposed population average 1 μg Cd/l whole blood, with smokers exhibiting higher levels (see Section 5.1.6). Data presented in Section 5.1.6 shows that 95% of the general population not occupationally exposed to cadmium have CDB levels less than 5 μg Cd/l.

If total body burdens of cadmium remain low, CDB concentrations indicate recent exposure (i.e., daily intake). This conclusion is based on data showing that cigarette smokers exhibit CDB concentrations of 2-7 μg/l depending on the number of cigarettes smoked per day (Nordberg and Nordberg 1988), while CDB levels for those who quit smoking return to general population values (approximately 1 μg/l) within several weeks (Lauwerys et al. 1976). Based on these observations, Lauwerys et al. (1976) concluded that CDB has a biological half-life of a few weeks to less than 3 months. As indicated in Section 3.1.6, the upper 95th percentile for CDB levels observed among those who are not occupationally exposed to cadmium is 5 μg/l, which suggests that the absolute upper limit to the range reported for smokers by Nordberg and Nordberg may have been affected by an extreme value (i.e., beyond 2° above the mean).

Among occupationally-exposed workers, the occupational history of exposure to cadmium must be evaluated to interpret CDB levels. New workers, or workers with low exposures to cadmium, exhibit CDB levels that are representative of recent exposures, similar to the general population. However, for workers with a history of chronic exposure to cadmium, who have accumulated significant stores of cadmium in the kidneys/liver, part of the CDB concentrations appear to indicate body burden. If such workers are removed from cadmium exposure, their CDB levels remain elevated, possibly for years, reflecting prior long-term accumulation of cadmium in body tissues. This condition tends to occur, however, only beyond some threshold exposure value, and possibly indicates the capacity of body tissues to accumulate cadmium which cannot be excreted readily (Friberg and Elinder 1988; Nordberg and Nordberg 1988).

CDU is widely used as an indicator of cadmium body burdens (Nordberg and Nordberg 1988). CDU is the major route of elimination and, when CDU is measured, it is commonly expressed either as μg Cd/l urine (unadjusted), μg Cd/l urine (adjusted for specific gravity), or μg Cd/g CRTU (see Section 5.2.1). The metabolic model for CDU is less complicated than CDB, since CDU is dependent in large part on the body (i.e., kidney) burden of cadmium. However, a small proportion of CDU can still be attributed to recent cadmium exposure, particularly if exposure to high airborne concentrations of cadmium occurred. Note that CDU is subject to larger interindividual and day-to-day variations than CDB, so repeated measurements are recommended for CDU evaluations.

CDU is bound principally to metallothionein, regardless of whether the cadmium originates from metallothionein in plasma or from the cadmium pool accumulated in the renal tubules. Therefore, measurement of metallothionein in urine may provide information similar to CDU, while avoiding the contamination problems that may occur during collection and handling urine for cadmium analysis (Nordberg and Nordberg 1988). However, a commercial method for the determination of metallothionein at the sensitivity levels required under the final cadmium rule is not currently available; therefore, analysis of CDU is recommended.

Among the general population not occupationally exposed to cadmium, CDU levels average less than 1 μg/l (see Section 5.2.7). Normalized for creatinine (CRTU), the average CDU concentration of the general population is less than 1 μg/g CRTU. As cadmium accumulates over the lifespan, CDU increases with age. Also, cigarette smokers may eventually accumulate twice the cadmium body burden of nonsmokers, CDU is slightly higher in smokers than in nonsmokers, even several years after smoking cessation (Nordberg and Nordberg 1988). Despite variations due to age and smoking habits, 95% of those not occupationally exposed to cadmium exhibit levels of CDU less than 3 μg/g CRTU (based on the data presented in Section 5.2.7).

About 0.02% of the cadmium body burden is excreted daily in urine. When the critical cadmium concentration (about 200 ppm) in the kidney is reached, or if there is sufficient cadmium- induced kidney dysfunction, dramatic increases in CDU are observed (Nordberg and Nordberg 1988). Above 200 ppm, therefore, CDU concentrations cease to be an indicator of cadmium body burden, and are instead an index of kidney failure.

Proteinuria is an index of kidney dysfunction, and is defined by OSHA to be a material impairment. Several small proteins may be monitored as markers for proteinuria. Below levels indicative of proteinuria, these small proteins may be early indicators of increased risk of cadmium-induced renal tubular disease. Analytes useful for monitoring cadmium-induced renal tubular damage include:

1. β-2-Microglobulin (B2M), currently the most widely used assay for detecting kidney dysfunction, is the best characterized analyte available (Iwao et al. 1980; Chia et al. 1989);

2. Retinol Binding Protein (RBP) is more stable than B2M in acidic urine (i.e., B2M breakdown occurs if urinary pH is less than 5.5; such breakdown may result in false [i.e., low] B2M values [Bernard and Lauwerys, 1990]);

3. N-Acetyl-B-Glucosaminidase (NAG) is the analyte of an assay that is simple, inexpensive, reliable, and correlates with cadmium levels under 10 μg/g CRTU, but the assay is less sensitive than RBP or B2M (Kawada et al. 1989);

4. Metallothionein (MT) correlates with cadmium and B2M levels, and may be a better predictor of cadmium exposure than CDU and B2M (Kawada et al. 1989);

5. Tamm-Horsfall Glycoprotein (THG) increases slightly with elevated cadmium levels, but this elevation is small compared to increases in urinary albumin, RBP, or B2M (Bernard and Lauwerys 1990);

6. Albumin (ALB), determined by the biuret method, is not sufficiently sensitive to serve as an early indicator of the onset of renal disease (Piscator 1962);

7. Albumin (ALB), determined by the Amido Black method, is sensitive and reproducible, but involves a time-consuming procedure (Piscator 1962);

8. Glycosaminoglycan (GAG) increases among cadmium workers, but the significance of this effect is unknown because no relationship has been found between elevated GAG and other indices of tubular damage (Bernard and Lauwerys 1990);

9. Trehalase seems to increase earlier than B2M during cadmium exposure, but the procedure for analysis is complicated and unreliable (Iwata et al. 1988); and,

10. Kallikrein is observed at lower concentrations among cadmium-exposed workers than among normal controls (Roels et al. 1990).

Of the above analytes, B2M appears to be the most widely used and best characterized analyte to evaluate the presence/absence, as well as the extent of, cadmium-induced renal tubular damage (Kawada, Koyama, and Suzuki 1989; Shaikh and Smith 1984; Nogawa 1984). However, it is important that samples be collected and handled so as to minimize B2M degradation under acidic urine conditions.

The threshold value of B_2MU commonly used to indicate the presence of kidney damage 300 μg/g CRTU (Kjellstrom et al. 1977a; Buchet et al. 1980; and Kowal and Zirkes 1983). This value represents the upper 95th or 97.5th percentile level of urinary excretion observed among those without tubular dysfunction (Elinder, exbt L-140-45, OSHA docket H057A). In agreement with these conclusions, the data presented in Section 5.3.7 of this protocol generally indicate that the level of 300 μg/g CRTU appears to define the boundary for kidney dysfunction. It is not clear, however, that this level represents the upper 95th percentile of values observed among those who fail to demonstrate proteinuria effects.

Although elevated B_2MU levels appear to be a fairly specific indicator of disease associated with cadmium exposure, other conditions that may lead to elevated B_2MU levels include high fevers from influenza, extensive physical exercise, renal disease unrelated to cadmium exposure, lymphomas, and AIDS (Iwao et al. 1980; Schardun and van Epps 1987). Elevated B2M levels observed in association with high fevers from influenza or from extensive physical exercise are transient, and will return to normal levels once the fever has abated or metabolic rates return to baseline values following exercise. The other conditions linked to elevated B2M levels can be diagnosed as part of a properly-designed medical examination. Consequently, monitoring B2M, when accompanied by regular medical examinations and CDB and CDU determinations (as indicators of present and past cadmium exposure), may serve as a specific, early indicator of cadmium-induced kidney damage.

4.4 Criteria for Medical Monitoring of Cadmium Workers.

Medical monitoring mandated by the final cadmium rule includes a combination of regular medical examinations and periodic monitoring of 3 analytes: CDB, CDU and B_2MU. As indicated above, CDB is monitored as an indicator of current cadmium exposure, while CDU serves as an indicator of the cadmium body burden; B_2MU is assessed as an early marker of irreversible kidney damage and disease.

The final cadmium rule defines a series of action levels that have been developed for each of the 3 analytes to be monitored. These action levels serve to guide the responsible physician through a decision-making process. For each action level that is exceeded, a specific response is mandated. The sequence of action levels, and the attendant actions, are described in detail in the final cadmium rule.

Other criteria used in the medical decision-making process relate to tests performed during the medical examination (including a determination of the ability of a worker to wear a respirator). These criteria, however, are not affected by the results of the analyte determinations addressed in the above paragraphs and, consequently, will not be considered further in these guidelines.

4.5 Defining to Quality and Proficiency of the Analyte Determinations.

As noted above in Sections 2 and 3, the quality of a measurement should be defined along with its value to properly interpret the results. Generally, it is necessary to know the accuracy and the precision of a measurement before it can be properly evaluated. The precision of the data from a specific laboratory indicates the extent to which the repeated measurements of the same sample vary within that laboratory. The accuracy of the data provides an indication of the extent to which these results deviate from average results determined from many laboratories performing the same measurement (i.e., in the absence of an independent determination of the true value of a measurement). Note that terms are defined operationally relative to the manner in which they will be used in this protocol. Formal definitions for the terms in italics used in this section can be found in the list of definitions (Section 2).

Another data quality criterion required to properly evaluate measurement results is the limit of detection of that measurement. For measurements to be useful, the range of the measurement which is of interest for biological monitoring purposes must lie entirely above the limit of detection defined for that measurement.

The overall quality of a laboratory's results is termed the performance of that laboratory. The degree to which a laboratory satisfies a minimum performance level is referred to as the proficiency of the laboratory. A successful medical monitoring program, therefore, should include procedures developed for monitoring and recording laboratory performance; these procedures can be used to identify the most proficient laboratories.

5.0 Overview of Medical Monitoring Tests for CDB, CDU, B_2MU and CRTU

To evaluate whether available methods for assessing CDB, CDU, B_2MU and CRTU are adequate for determining the parameters defined by the proposed action levels, it is necessary to review procedures available for sample collection, preparation and analysis. A variety of techniques for these purposes have been used historically for the determination of cadmium in biological matrices (including CDB and CDU), and for the determination of specific proteins in biological matrices (including B_2MU). However, only the most recent techniques are capable of satisfying the required accuracy, precision and sensitivity (i.e., limit of detection) for monitoring at the levels mandated in the final cadmium rule, while still facilitating automated analysis and rapid processing.

5.1 Measuring Cadmium in Blood (CDB).

Analysis of biological samples for cadmium requires strict analytical discipline regarding collection and handling of samples. In addition to occupational settings, where cadmium contamination would be apparent, cadmium is a ubiquitous environmental contaminant, and much care should be exercised to ensure that samples are not contaminated during collection, preparation or analysis. Many common chemical reagents are contaminated with cadmium at concentrations that will interfere with cadmium analysis; because of the widespread use of cadmium compounds as colored pigments in plastics and coatings, the analyst should continually monitor each manufacturer's chemical reagents and collection containers to prevent contamination of samples.

Guarding against cadmium contamination of biological samples is particularly important when analyzing blood samples

because cadmium concentrations in blood samples from nonexposed populations are generally less than 2 μg/l (2 ng/ml), while occupationally- exposed workers can be at medical risk to cadmium toxicity if blood concentrations exceed 5 μg/l (ACGIH 1991 and 1992). This narrow margin between exposed and unexposed samples requires that exceptional care be used in performing analytic determinations for biological monitoring for occupational cadmium exposure.

Methods for quantifying cadmium in blood have improved over the last 40 years primarily because of improvements in analytical instrumentation. Also, due to improvements in analytical techniques, there is less need to perform extensive multi-step sample preparations prior to analysis. Complex sample preparation was previously required to enhance method sensitivity (for cadmium), and to reduce interference by other metals or components of the sample.

5.1.1 Analytical Techniques Used to Monitor Cadmium in Biological Matrices

A number of analytical techniques have been used for determining cadmium concentrations in biological materials. A summary of the characteristics of the most widely employed techniques is presented in Table 3. The technique most suitable for medical monitoring for cadmium is atomic absorption spectroscopy (AAS).

To obtain a measurement using AAS, a light source (i.e., hollow cathode or lectrode-free discharge lamp) containing the element of interest as the cathode, is energized and the lamp emits a spectrum that is unique for that element. This light source is focused through a sample cell, and a selected wavelength is monitored by a monochrometer and photodetector cell. Any ground state atoms in the sample that match those of the lamp element and are in the path of the emitted light may absorb some of the light and decrease the amount of light that reaches the photodetector cell. The amount of light absorbed at each characteristic wavelength is proportional to the number of ground state atoms of the corresponding element that are in the pathway of the light between the source and detector.

To determine the amount of a specific metallic element in a sample using AAS, the sample is dissolved in a solvent and aspirated into a high-temperature flame as an aerosol. At high temperatures, the solvent is rapidly evaporated or decomposed and the solute is initially solidified; the majority of the sample elements then are transformed into an atomic vapor. Next, a light beam is focused above the flame and the amount of metal in the sample can be determined by measuring the degree of absorbance of the atoms of the target element released by the flame at a characteristic wavelength.

A more refined atomic absorption technique, flameless AAS, substitutes an electrothermal, graphite furnace for the flame. An aliquot (10-100 μl) of the sample is pipetted into the cold furnace, which is then heated rapidly to generate an atomic vapor of the element.

AAS is a sensitive and specific method for the elemental analysis of metals; its main drawback is nonspecific background absorbtion and scattering of the light beam by particles of the sample as it decomposes at high temperatures; nonspecific absorbance reduces the sensitivity of the analytical method. The problem of nonspecific absorbance and scattering can be reduced by extensive sample pretreatment, such as ashing and/or acid digestion of the sample to reduce its organic content.

Current AAS instruments employ background correction devices to adjust electronically for background absorbtion and scattering. A common method to correct for background effects is to use a deuterium arc lamp as a second light source. A continuum light source, such as the deuterium lamp, emits a broad spectrum of wavelengths instead of specific wavelengths characteristic of a particular element, as with the hollow cathode tube. With this system, light from the primary

Table 3.-Comparison of Analytical Procedures/Instrumentation for Determination of Cadmium in Biological Samples

Analytical procedure	Limit of detection [ng/(g or ml)]	Specified biological matrix	Reference	Comments
Flame Atomic Absorption Spectroscopy (FAAS)	≥1.0	Any matrix	Perkin-Elmer (1982)	Not sensitive enough for biomonitoring without extensive sample digestion, metal chelation and organic solvent extraction.
Graphite Furnace Atomic Absorption Spectroscopy (GFAAS)	0.04	Urine	Pruszkowska et al.(1983)	Methods of choice forroutine cadmium analysis.
	≥0.20	Blood	Stoeppler and Brandt (1980)	
Inductively-Coupled Argon-Plasma Atomic Emission Spectroscopy (ICAP AES)	2.0	Any matrix	NIOSH (1984A)	Requires extensive sample preparation and concentration of metal with chelating resin. Advantage is simultaneous analyses for as many as 10 metals from 1 sample.
Neutron Activation Gamma Spectroscopy (NA)	1.5	In vivo (liver)	Ellis et al. (1983)	Only available *in vivo* method for direct determination of cadmium body tissue burdens; expensive; absolute determination of cadmium in reference materials.
Isotope Dilution Mass Spectroscopy (IDMS)	<1.0	Any matrix	Michiels and DeBievre (1986)	Suitable for absolute determination of cadmium in reference materials; expensive.
Differential Pulse Anodic Stripping Voltammetry (DPASV)	<1.0	Any matrix	Stoeppler and Brandt (1980)	Suitable for absolute determination of cadmium in reference materials; efficient method to check accuracy of analytical method.

source and the continuum source are passed alternately through the sample cell. The target element effectivelyabsorbs light only from the primary source (which is much brighter than the continuum source at the characteristic wavelengths), while the background matrix absorbs and scatters light from both sources equally. Therefore, when the ratio of the two beams is measured electronically, the effect of nonspecific background absorption and scattering is eliminated. A less common, but more sophisticated, backgrond correction system is based on the Zeeman effect, which uses a magnetically-activated light polarizer to compensate electronically for nonspecific absorbtion and scattering.

Atomic emission spectroscopy with inductively-coupled argon plasma (AES-ICAP) is widely used to analyze for metals. With this instrument, the sample is aspirated into an extremely hot argon plasma flame, which excites the metal atoms; emission spectra specific for the sample element then are generated. The quanta of emitted light passing through a monochrometer are amplified by photomultiplier tubes and measured by a photodetector to determine the amount of metal in the sample. An advantage of AES-ICAP over AAS is that multielemental analyses of a sample can be performed by simultaneously measuring specific elemental emission energies. However, AES-ICAP lacks the sensitivity of AAS, exhibiting a limit of detection which is higher than the limit of detection for graphite-furnace AAS (Table 3).

Neutron activation (NA) analysis and isotope dilution mass spectrometry (IDMS) are 2 additional, but highly specialized, methods that have been used for cadmium determinations. These methods are expensive because they require elaborate and sophisticated instrumentation.

NA analysis has the distinct advantage over other analytical methods of being able to determine cadmium body burdens in specific organs (e.g., liver, kidney) in vivo (Ellis et al. 1983). Neutron bombardment of the target transforms cadmium-113 to cadmium-114, which promptly decays ($<10^{-14}$ sec) to its ground state, emitting gamma rays that are measured using large gamma detectors; appropriate shielding and instrumentation are required when using this method.

IDMS analysis, a definitive but laborious method, is based on the change in the ratio of 2 isotopes of cadmium (cadmium 111 and 112) that occurs when a known amount of the element (with an artificially altered ratio of the same isotopes [i.e., a cadmium 111 "spike"] is added to a weighed aliquot of the sample (Michiels and De Bievre 1986).

5.1.2 Methods Developed for CDB Determinations

A variety of methods have been used for preparing and analyzing CDB samples; most of these methods rely on one of the analytical techniques described above. Among the earliest reports, Princi (1947) and Smith et al. (1955) employed a colorimetric procedure to analyze for CDB and CDU. Samples were dried and digested through several cycles with concentrated mineral acids (HNO_3 and H_2SO_4) and hydrogen peroxide (H_2O_2). The digest was neutralized, and the cadmium was complexed with diphenylthiocarbazone and extracted with chloroform. The dithizone-cadmium complex then was quantified using a spectrometer.

Colorimetric procedures for cadmium analyses were replaced by methods based on atomic absorption spectroscopy (AAS) in the early 1960s, but many of the complex sample preparation procedures were retained. Kjellstrom (1979) reports that in Japanese, American and Swedish laboratories during the early 1970s, blood samples were wet ashed with mineral acids or ashed at high temperature and wetted with nitric acid. The cadmium in the digest was complexed with metal chelators including diethyl dithiocarbamate (DDTC), ammonium pyrrolidine dithiocarbamate (APDC) or diphenylthiocarbazone (dithizone) in ammonia-citrate buffer and extracted with methyl isobutyl ketone (MIBK). The resulting solution then was analyzed by flame AAS or graphite- furnace AAS forcadmium determinations using deuterium-lamp background correction.

In the late 1970s, researchers began developing simpler preparation procedures. Roels et al. (1978) and Roberts and Clark (1986) developed simplified digestion procedures. Using the Roberts and Clark method, a 0.5 ml aliquot of blood is collected and transferred to a digestion tube containing 1 ml concentrated HNO_3. The blood is then digested at 110 °C for 4 hours. The sample is reduced in volume by continued heating, and 0.5 ml 30% H_2O_2 is added as the sample dries. The residue is dissolved in 5 ml dilute (1%) HNO_3, and 20 µl of sample is then analyzed by graphite-furnace AAS with deuterium-background correction.

The current trend in the preparation of blood samples is to dilute the sample and add matrix modifiers to reduce background interference, rather than digesting the sample to reduce organic content. The method of Stoeppler and Brandt (1980), and the abbreviated procedure published in the American Public Health Association's (APHA) *Methods for Biological Monitoring* (1988), are straightforward and are nearly identical. For the APHA method, a small aliquot (50-300 µl) of whole blood that has been stabilized with ethylenediaminetetraacetate (EDTA) is added to 1.0 ml 1M HNO_3, vigorously shaken and centrifuged. Aliquots (10-25 µl) of the supernatant then are then analyzed by graphite-furnace AAS with appropriate background correction.

Using the method of Stoeppler and Brandt (1980), aliquots (50-200 µl) of whole blood that have been stabilized with EDTA are pipetted into clean polystyrene tubes and mixed with 150- 600 µl of 1M HNO_3. After vigorous shaking, the solution is centrifuged and a 10-25 µl aliquot of the supernatant then is analyzed by graphite-furnace AAS with appropriate background correction.

Claeys-Thoreau (1982) and DeBenzo et al. (1990) diluted blood samples at a ratio of 1:10 with a matrix modifier (0.2% Triton X-100, a wetting agent) for direct determinations of CDB. DeBenzo et al. also demonstrated that aqueous standards of cadmium, instead of spiked, whole-blood samples, could be used to establish calibration curves if standards and samples are treated with additional small volumes of matrix modifiers (i.e., 1% HNO_3, 0.2% ammonium hydrogenphosphate and 1 mg/ml magnesium salts).

These direct dilution procedures for CDB analysis are simple and rapid. Laboratories can process more than 100 samples a day using a dedicated graphite-furnace AAS, an auto-sampler, and either a Zeeman- or a deuterium-background correction system. Several authors emphasize using optimum settings for graphite- furnace temperatures during the drying, charring, and atomization processes associated with the flameless AAS method, and the need to run frequent QC samples when performing automated analysis.

5.1.3 Sample Collection and Handling.

Sample collection procedures are addressed primarily to identify ways to minimize the degree of variability that may be introduced by sample collection during medical monitoring. It is unclear at this point the extent to which collection procedures contribute to variability among CDB samples. Sources of variation that may result from sampling procedures include time-of-day effects and introduction of external contamination during the collection process. To minimize these sources, strict adherence to a sample collection protocol is recommended. Such a protocol must include provisions for thorough cleaning of the site from which blood will be extracted; also, every effort should be made to collect samples near the same time of day. It is also important to recognize that under the recent OSHA blood-borne pathogens

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standard (29 CFR 1910.1030), blood samples and certain body fluids must be handled and treated as if they are infectious.

5.1.4 Best Achievable Performance.

The best achievable performance using a particular method for CDB determinations is assumed to be equivalent to the performance reported by research laboratories in which the method was developed.

For their method, Roberts and Clark (1986) demonstrated a limit of detection of 0.4 μg Cd/l in whole blood, with a linear response curve from 0.4 to 16.0 μg Cd/l. They report a coefficient of variation (CV) of 6.7% at 8.0 μg/l.

The APHA (1988) reports a range of 1.0-25 μg/l, with a CV of 7.3% (concentration not stated). Insufficient documentation was available to critique this method.

Stoeppler and Brandt (1980) achieved a detection limit of 0.2 μg Cd/l whole blood, with a linear range of 0.4-12.0 μg Cd/l, and a CV of 15-30%, for samples at *1.0 μg/l. Improved precision (CV of 3.8%) was reported for CDB concentrations at 9.3 μg/l.

5.1.5 General Method Performance.

For any particular method, the performance expected from commercial laboratories may be somewhat lower than that reported by the research laboratory in which the method was developed. With participation in appropriate proficiency programs and use of a proper in-house QA/QC program incorporating provisions for regular corrective actions, the performance of commercial laboratories is expected to approach that reported by research laboratories. Also, the results reported for existing proficiency programs serve as a gauge of the likely level of performance that currently can be expected from commercial laboratories offering these analyses.

Weber (1988) reports on the results of the proficiency program run by the Centre de Toxicologie du Quebec (CTQ). As indicated previously, participants in that program receive 18 blood samples per year having cadmium concentrations ranging from 0.2-20 μg/l. Currently, 76 laboratories are participating in this program. The program is established for several analytes in addition to cadmium, and not all of these laboratories participate in the cadmium proficiency-testing program.

Under the CTQ program, cadmium results from individual laboratories are compared against the consensus mean derived for each sample. Results indicate that after receiving 60 samples (i.e., after participation for approximately three years), 60% of the laboratories in the program are able to report results that fall within ±1 μg/l or 15% of the mean, whichever is greater. (For this procedure, the 15% criterion was applied to concentrations exceeding 7 μg/l.) On any single sample of the last 20 samples, the percentage of laboratories falling within the specified range is between 55 and 80%.

The CTQ also evaluates the performance of participating laboratories against a less severe standard: ±2 μg/l or 15% of the mean, whichever is greater (Weber 1988); 90% of participating laboratories are able to satisfy this standard after approximately 3 years in the program. (The 15% criterion is used for concentrations in excess of 13 μg/l.) On any single sample of the last 15 samples, the percentage of laboratories falling within the specified range is between 80 and 95% (except for a single test for which only 60% of the laboratories achieved the desired performance).

Based on the data presented in Weber (1988), the CV for analysis of CDB is nearly constant at 20% for cadmium concentrations exceeding 5 μg/l, and increases for cadmium concentrations below 5 μg/l. At 2 μg/l, the reported CV rises to approximately 40%. At 1 μg/l, the reported CV is approximately 60%.

Participating laboratories also tend to overestimate concentrations for samples exhibiting concentrations less than 2 μg/l (see Figure 11 of Weber 1988). This problem is due in part to the proficiency evaluation criterion that allows reporting a minimum ±2.0 μg/l for evaluated CDB samples. There is currently little economic or regulatory incentive for laboratories participating in the CTQ program to achieve greater accuracy for CDB samples containing cadmium at concentrations less than 2.0 μg/l, even if the laboratory has the experience and competency to distinguish among lower concentrations in the samples obtained from the CTQ.

The collective experience of international agencies and investigators demonstrate the need for a vigorous QC program to ensure that CDB values reported by participating laboratories are indeed reasonably accurate. As Friberg (1988) stated:

"Information about the quality of published data has often been lacking. This is of concern as assessment of metals in trace concentrations in biological media are fraught with difficulties from the collection, handling, and storage of samples to the chemical analyses. This has been proven over and over again from the results of interlaboratory testing and quality control exercises. Large variations in results were reported even from 'experienced' laboratories.".

The UNEP/WHO global study of cadmium biological monitoring set a limit for CDB accuracy using the maximum allowable deviation method at $Y=X \pm (0.1X+1)$ for a targeted concentration of 10 μg Cd/l (Friberg and Vahter 1983). The performance of participating laboratories over a concentration range of 1.5-12 μg/l was reported by Lind et al. (1987). Of the 3 QC runs conducted during 1982 and 1983, 1 or 2 of the 6 laboratories failed each run. For the years 1983 and 1985, between zero and 2 laboratories failed each of the consecutive QC runs.

In another study (Vahter and Friberg 1988), QC samples consisting of both external (unknown) and internal (stated) concentrations were distributed to laboratories participating in the epidemiology research. In this study, the maximum acceptable deviation between the regression analysis of reported results and reference values was set at $Y=X \pm (0.05X+0.2)$ for a concentration range of 0.3-5.0 μg Cd/l. It is reported that only 2 of 5 laboratories had acceptable data after the first QC set, and only 1 of 5 laboratories had acceptable data after the second QC set. By the fourth QC set, however, all 5 laboratories were judged proficient.

The need for high quality CDB monitoring is apparent when the toxicological and biological characteristics of this metal are considered; an increase in CDB from 2 to 4 μg/l could cause a doubling of the cadmium accumulation in the kidney, a critical target tissue for selective cadmium accumulation (Nordberg and Nordberg 1988).

Historically, the CDC's internal QC program for CDB cadmium monitoring program has found achievable accuracy to be ±10% of the true value at CDB concentrations ±5.0 μg/l (Paschal 1990). Data on the performance of laboratories participating in this program currently are not available.

5.1.6 Observed CDB Concentrations.

As stated in Section 4.3, CDB concentrations are representative of ongoing levels of exposure to cadmium. Among those who have been exposed chronically to cadmium for extended periods, however, CDB may contain a component attributable to the general cadmium body burden.

5.1.6.1 CDB Concentrations Among Unexposed Samples.

Numerous studies have been conducted examining CDB concentrations in the general population, and in control groups used for comparison with cadmium-exposed workers. A number of reports have been published that present erroneously high values of CDB (Nordberg and Nordberg 1988). This problem

was due to contamination of samples during sampling and analysis, and to errors in analysis. Early AAS methods were not sufficiently sensitive to accurately estimate CDB concentrations.

Table 4 presents results of recent studies reporting CDB levels for the general U.S. population not exposed occupationally to cadmium. Other surveys of tissue cadmium using U.S. samples and conducted as part of a cooperative effort among Japan, Sweden and the U.S., did not collect CDB data because standard analytical methodologies were unavailable, and because of analytic problems (Kjellstrom 1979; SWRI 1978).

Arithmetic and/or geometric means and standard deviations are provided in Table 4 for measurements among the populations defined in each study listed. The range of reported measurements and/or the 95% upper and lower confidence intervals for the means are presented when this information was reported in a study. For studies reporting either an arithmetic or geometric standard deviation along with a mean, the lower and upper 95th percentile for the distribution also were derived and reported in the table.

The data provided in Table 4 from Kowal et al. (1979) are from studies conducted between 1974 and 1976 evaluating CDB levels for the general population in Chicago, and are considered to be representative of the U.S. population. These studies indicate that the average CDB concentration among those not occupationally exposed to cadmium is approximately 1 μg/l.

In several other studies presented in Table 4, measurements are reported separately for males and females, and for smokers and nonsmokers. The data in this table indicate that similar CDB levels are observed among males and females in the general population, but that smokers tend to exhibit higher CDB levels than nonsmokers. Based on the Kowal et al. (1979) study, smokers not occupationally exposed to cadmium exhibit an average CDB level of 1.4 μg/l.

In general, nonsmokers tend to exhibit levels ranging to 2 μg/l, while levels observed among smokers range to 5 μg/l. Based on the data presented in Table 4, 95% of those not occupationally exposed to cadmium exhibit CDB levels less than 5 μg/l.

5.1.6.2 CDB Concentrations Among Exposed Workers

Table 5 is a summary of results from studies reporting CDB levels among workers exposed to cadmium in the work place. As in Table 4, arithmetic and/or geometric means and standard deviations are provided if reported in the listed studies. The absolute range, or the 95% confidence interval around the mean, of the data in each study are provided when reported. In addition, the lower and upper 95th percentile of the distribution are presented for each study in which a mean and corresponding standard deviation were reported. Table 5 also provides estimates of the duration, and level, of exposure to cadmium in the work place if these data were reported in the listed studies. The data presented in Table 5 suggest that CDB levels are dose related. Sukuri et al. (1983) show that higher CDB levels are observed among workers experiencing higher work place exposure. This trend appears to be true of every one of the studies listed in the table.

CDB levels reported in Table 5 are higher among those showing signs of cadmium-related kidney damage than those showing no such damage. Lauwerys et al. (1976) report CDB levels among workers with kidney lesions that generally are above the levels reported for workers without kidney lesions. Ellis et al. (1983) report a similar observation comparing workers with and without renal dysfunction, although they found more overlap between the 2 groups than Lauwerys et al.

Table 4.-Blood Cadmium Concentrations of U.S. Population Not Occupationally Exposed to Cadmium[a]

Study No.	No. in study (n)	Sex	Age	Smoking habits[b]	Arithmetic mean (±SD)[c]	Absolute range or (95% CI)[d]	Geometric mean (±GSD)[e]	Lower 95th percentile of distribution[f]	Upper 95th percentile of distribution[f]	Reference
1	80	M	4 to 69	NS,S	1.13	0.35-3.3	0.98 ±1.71	0.4	2.4	Kowal et al. (1979)
	88	F	4 to 69	NS,S	1.03	0.21-3.3	0.91±1.63	0.4	2.0	
	115	M/F	4 to 69	NS	0.95	0.21-3.3	0.85±1.59	0.4	1.8	
	31	M/F	4 to 69	S	1.54	0.4-3.3	1.37±1.65	0.6	3.2	
2	10	M	Adults	(?)	2.0±2.1	(0.5-5.0)		[g](0)	[g](5.8)	Ellis et al. (1983)
3	24	M	Adults	NS			0.6±1/87	0.2	1.8	Frieberg and Vahter (1983)
	20	M	Adults	S			1.2±2.13	0.3	4.4	
	64	F	Adults	NS			0.5±1.85	0.2	1.4	
	39	F	Adults	S			0.8±2.22	0.2	3.1	
4	32	M	Adults	S,NS			1.2±2.0	0.4	3.9	Thun et al. (1989)
5	35	M	Adults	(?)	2.1±2.1	(0.5-7.3)		(0)	[g](5.6)	Mueller et al. (1989)

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Table 5. Blood Cadmium in Workers Exposed to Cadmium in the Workplace

Study No.	Work environment (worker population monitored)	No. in study	Employment in years (mean)	Mean concentration of cadmium in air (μg/m³)	Arithmetic mean (±SD)[b]	Absolute range or (95% CI)[c]	Geometric mean (±GSD)[d]	Lower 95th percentile of distribution[f]	Upper 95th percentile of distribution[f]	Reference
1	Ni-Cd battery plant and Cd production plant:		3-40	❊90						Lauwerys et al. 1976.
	(Workers without kidney lesions)	96			21.4±1.9			(18)	(25)	
	(Workers with kidney lesions)	25			38.8±3.8			(32)	(45)	
2	Ni-Cd battery plant:									Adamsson et al. (1979)
	(Smokers)	7	(5)	10.1	02.7	7.3-67.2				
	(Non-smokers)	8	(9)	7.0	7.0	4.9-10.5				
3	Cadmium alloy plant:									Sukuri et al. 1982
	(High exposure group)	7	(10.6)	[1,000-5 yrs;	20.8±7.1			(7.3)	(34)	
	(Low exposure group)	9	(7.3)	40-5 yrs]	yrs]	7.1±1.1			(5.1)	(9.1)
4	Retrospective study of workers with renal problems:	19	15-41							Roels et al. 1982
	(Before removal)		(27.2)		39.9±3.7	11-179		(34)	(46)	
	(After removal)		g(4.2)		14.1±5.6	5.7-27.4		(4.4)	(24)	
5	Cadmium production plant:									Ellis et al. 1983
	(Workers without renal dysfunction)	33	1-34		15±5.7	7-31		(5.4)	(25)	
	(Workers with renal dysfunction)	18	10-34		24±0.5	10-34		(9.3)	(39)	
6	Cd-Cu alloy plant	75	Up to 39				8.8±1.1	7.5	10	Mason et al. 1988
7	Cadmium recovery operation-Current (19) and former (26) workers	45	(19.0)				7.9±2.0	2.5	25	Thun et al. 1989
8	Cadmium recovery operation	40			10.2±5.3	2.2-18.8		(1.3)	(19)	Mueller et al. 1989

The data in Table 5 also indicate that CDB levels are higher among those experiencing current occupational exposure than those who have been removed from such exposure. Roels et al. (1982) indicate that CDB levels observed among workers experiencing ongoing exposure in the work place are almost entirely above levels observed among workers removed from such exposure. This finding suggests that CDB levels decrease once cadmium exposure has ceased.

A comparison of the data presented in Tables 4 and 5 indicates that CDB levels observed among cadmium-exposed workers is significantly higher than levels observed among the unexposed groups. With the exception of 2 studies presented in Table 5 (1 of which includes former workers in the sample group tested), the lower 95th percentile for CDB levels among exposed workers are greater than 5 μg/l, which is the value of the upper 95th percentile for CDB levels observed among those who are not occupationally exposed. Therefore, a CDB level of 5 μg/l represents a threshold above which significant work place exposure to cadmium may be occurring.

5.1.7 Conclusions and Recommendations for CDB.

Based on the above evaluation, the following recommendations are made for a CDB proficiency program.

5.1.7.1 Recommended Method.

The method of Stoeppler and Brandt (1980) should be adopted for analyzing CDB. This method was selected over other methods for its straightforward sample-preparation procedures, and because limitations of the method were described adequately. It also is the method used by a plurality of laboratories currently participating in the CTQ proficiency program. In a recent CTQ interlaboratory comparison report (CTQ 1991), analysis of the methods used by laboratories to measure CDB indicates that 46% (11 of 24) of the participating laboratories used the Stoeppler and Brandt methodology (HNO_3 deproteinization of blood followed by analysis of the supernatant by GF-AAS). Other CDB methods employed by participating laboratories identified in the CTQ report include dilution of blood (29%), acid digestion (12%) and miscellaneous methods (12%).

Laboratories may adopt alternate methods, but it is the responsibility of the laboratory to demonstrate that the alternate methods meet the data quality objectives defined for the Stoeppler and Brandt method (see section 5.1.7.2 below).

5.1.7.2 Data Quality Objectives.

Based on the above evaluation, the following data quality objectives (DQOs) should facilitate interpretation of analytical results.

Limit of Detection. 0.5 μg/l should be achievable using the Stoeppler and Brandt method. Stoeppler and Brandt (1980) report a limit of detection equivalent to s.02 μg/l in whole blood using 25 μl aliquots of deproteinized, diluted blood samples.

Accuracy. Initially, some of the laboratories performing CDB measurements may be expected to satisfy criteria similar to the less severe criteria specified by the CTQ program, i.e., measurements within 2 μg/l or 15% (whichever is greater) of the target value. About 60% of the laboratories enrolled in the CTQ program could meet this criterion on the first proficiencey test (Weber 1988).

Currently, approximately 12 laboratories in the CTQ program are achieving an accuracy for CDB analysis within the more severe constraints of ±1 μg/l or 15% (whichever is greater). Later, as laboratories gain experience, they should achieve the level of accuracy exhibited by these 12 laboratories. The experience in the CTQ program has shown that, even without incentives, laboratories benefit from the feedback of the program; after they have analyzed 40-50 control samples from the program, performance improves to the point where about 60% of the laboratories can meet the stricter criterion of ±1 μg/l or 15% (Weber 1988). Thus, this stricter target accuracy is a reasonable DQO.

Precision. Although Stoeppler and Brandt (1980) suggest that a coefficient of variation (CV) near 1.3% (for a 10 μg/l concentration) is achievable for within-run reproducibility, it is recognized that other factors affecting within- and between-run comparability will increase the achievable CV. Stoeppler and Brandt (1980) observed CVs that were as high as 30% for low concentrations (0.4 μg/l), and CVs of less than 5% for higher concentrations.

For internal QC samples (see section 3.3.1), laboratories should to attain an overall precision near 25%. For CDB samples with concentrations less than 2 μg/l, a target precision of 40% is reasonable, while precisions of 20% should be achievable for concentrations greater than 2 μg/l. Although these values are more strict than values observed in the CTQ interlaboratory program reported by Webber (1988), they are within the achievable limits reported by Stoeppler and Brandt (1980).

5.1.7.3 Quality Assurance/Quality Control.

Commercial laboratories providing measurement of CDB should adopt an internal QA/QC program that incorporates the following components: Strict adherence to the selected method, including all calibration requirements; regular incorporation of QC samples during actual runs; a protocol for corrective actions, and documentation of these actions; and, participation in an interlaboratory proficiency program. Note that the nonmandatory QA/QC program presented in Attachment 1 is based on the Stoeppler and Brandt method for CDB analysis. Should an alternate method be adopted, the laboratory should develop a QA/QC program satisfying the provisions of Section 3.3.1.

5.2 Measuring Cadmium in Urine (CDU).

As in the case of CDB measurement, proper determination of CDU requires strict analytical discipline regarding collection and handling of samples. Because cadmium is both ubiquitous in the environment and employed widely in coloring agents for industrial products that may be used during sample collection, preparation and analysis, care should be exercised to ensure that samples are not contaminated during the sampling procedure.

Methods for CDU determination share many of the same features as those employed for the determination of CDB. Thus, changes and improvements to methods for measuring CDU over the past 40 years parallel those used to monitor CDB. The direction of development has largely been toward the simplification of sample preparation techniques made possible because of improvements in analytic techniques.

5.2.1 Units of CDU Measurement.

Procedures adopted for reporting CDU concentrations are not uniform. In fact, the situation for reporting CDU is more complicated than for CDB, where concentrations are normalized against a unit volume of whole blood.

Concentrations of solutes in urine vary with several biological factors (including the time since last voiding and the volume of liquid consumed over the last few hours); as a result, solute concentrations should be normalized against another characteristic of urine that represents changes in solute concentrations. The 2 most common techniques are either to standardize solute concentrations against the concentration of creatinine, or to standardize solute concentrations against the specific gravity of the urine. Thus, CDU concentrations have been reported in the literature as "uncorrected" concentrations of cadmium per volume of urine (i.e., μg Cd/l urine), "corrected" concentrations of cadmium per volume of urine at a standard specific gravity (i.e., μg Cd/l urine at a specific gravity of 1.020), or "corrected" mass concentra-

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tion per unit mass of creatinine (i.e., μg Cd/g creatinine). (CDU concentrations [whether uncorrected or corrected for specific gravity, or normalized to creatinine] occasionally are reported in nanomoles [i.e., nmoles] of cadmium per unit mass or volume. In this protocol, these values are converted to μg of cadmium per unit mass or volume using 89 nmoles of cadmium=10 μg.).

While it is agreed generally that urine values of analytes should be normalized for reporting purposes, some debate exists over what correction method should be used. The medical community has long favored normalization based on creatinine concentration, a common urinary constituent. Creatinine is a normal product of tissue catabolism, is excreted at a uniform rate, and the total amount excreted per day is constant on a day-to-day basis (NIOSH 1984b). While this correction method is accepted widely in Europe, and within some occupational health circles, Kowals (1983) argues that the use of specific gravity (i.e., total solids per unit volume) is more straightforward and practical (than creatinine) in adjusting CDU values for populations that vary by age or gender.

Kowals (1983) found that urinary creatinine (CRTU) is lower in females than males, and also varies with age. Creatinine excretion is highest in younger males (20-30 years old), decreases at middle age (50-60 years), and may rise slightly in later years. Thus, cadmium concentrations may be underestimated for some workers with high CRTU levels.

Within a single void urine collection, urine concentration of any analyte will be affected by recent consumption of large volumes of liquids, and by heavy physical labor in hot environments. The absolute amount of analyte excreted may be identical, but concentrations will vary widely so that urine must be corrected for specific gravity (i.e., to normalize concentrations to the quantity of total solute) using a fixed value (e.g., 1.020 or 1.024). However, since heavy-metal exposure may increase urinary protein excretion, there is a tendency to underestimate cadmium concentrations in samples with high specific gravities when specific-gravity corrections are applied.

Despite some shortcomings, reporting solute concentrations as a function of creatinine concentration is accepted generally; OSHA therefore recommends that CDU levels be reported as the mass of cadmium per unit mass of creatinine (μg/g CTRU).

Reporting CDU as μg/g CRTU requires an additional analytical process beyond the analysis of cadmium: Samples must be analyzed independently for creatinine so that results may be reported as the ratio of cadmium to creatinine concentrations found in the urine sample. Consequently, the overall quality of the analysis depends on the combined performance by a laboratory on these 2 determinations. The analysis used for CDU determinations is addressed below in terms of μg Cd/l, with analysis of creatinine addressed separately. Techniques for assessing creatinine are discussed in Section 5.4.

Techniques for deriving cadmium as a ratio of CRTU, and the confidence limits for independent measurements of cadmium and CRTU, are provided in Section 3.3.3.

5.2.2 Analytical Techniques Used to Monitor CDU.

Analytical techniques used for CDU determinations are similar to those employed for CDB determinations; these techniques are summarized in Table 3. As with CDB monitoring, the technique most suitable for CDU determinations is atomic absorption spectroscopy (AAS). AAS methods used for CDU determinations typically employ a graphite furnace, with background correction made using either the deuterium-lamp or Zeeman techniques; Section 5.1.1 provides a detailed description of AAS methods.

5.2.3 Methods Developed for CDU Determinations.

Princi (1947), Smith et al. (1955), Smith and Kench (1957), and Tsuchiya (1967) used colorimetric procedures similar to those described in the CDB section above to estimate CDU concentrations. In these methods, urine (50 ml) is reduced to dryness by heating in a sand bath and digested (wet ashed) with mineral acids. Cadmium then is complexed with dithiazone, extracted with chloroform and quantified by spectrophotometry. These early studies typically report reagent blank values equivalent to 0.3 μg Cd/l, and CDU concentrations among nonexposed control groups at maximum levels of 10 μg Cd/l-erroneously high values when compared to more recent surveys of cadmium concentrations in the general population.

By the mid-1970s, most analytical procedures for CDU analysis used either wet ashing (mineral acid) or high temperatures (≈400 °C) to digest the organic matrix of urine, followed by cadmium chelation with APDC or DDTC solutions and extraction with MIBK. The resulting aliquots were analyzed by flame or graphite-furnace AAS (Kjellstrom 1979).

Improvements in control over temperature parameters with electrothermal heating devices used in conjunction with flameless AAS techniques, and optimization of temperature programs for controlling the drying, charring, and atomization processes in sample analyses, led to improved analytical detection of diluted urine samples without the need for sample digestion or ashing. Roels et al. (1978) successfully used a simple sample preparation, dilution of 1.0 ml aliquots of urine with 0.1 N HNO_3, to achieve accurate low-level determinations of CDU.

In the method described by Pruszkowska et al. (1983), which has become the preferred method for CDU analysis, urine samples were diluted at a ratio of 1:5 with water; diammonium hydrogenphosphate in dilute HNO_3 was used as a matrix modifier. The matrix modifier allows for a higher charring temperature without loss of cadmium through volatilization during pre-atomization. This procedure also employs a stabilized temperature platform in a graphite furnace, while nonspecific background absorbtion is corrected using the Zeeman technique. This method allows for an absolute detection limit of approximately 0.04 μg Cd/l urine.

5.2.4 Sample Collection and Handling.

Sample collection procedures for CDU may contribute to variability observed among CDU measurements. Sources of variation attendant to sampling include time-of-day, the interval since ingestion of liquids, and the introduction of external contamination during the collection process. Therefore, to minimize contributions from these variables, strict adherence to a sample-collection protocol is recommended. This a protocol should include provisions for normalizing the conditions under which urine is collected. Every effort also should be made to collect samples during the same time of day.

Collection of urine samples from an industrial work force for biological monitoring purposes usually is performed using "spot" (i.e., single-void) urine with the pH of the sample determined immediately. Logistic and sample-integrity problems arise when efforts are made to collect urine over long periods (e.g., 24 hrs). Unless single-void urines are used, there are numerous opportunities for measurement error because of poor control over sample collection, storage and environmental contamination.

To minimize the interval during which sample urine resides in the bladder, the following adaption to the "spot" collection procedure is recommended: The bladder should first be emptied, and then a large glass of water should be consumed; the sample may be collected within an hour after the water is consumed.

5.2.5 Best Achievable Performance.

Performance using a particular method for CDU determinations is assumed to be equivalent to the performance reported by

the research laboratories in which the method was developed. Pruszkowska et al. (1983) report a detection limit of 0.04 μg/l CDU, with a CV of <4% between 0-5 μg/l. The CDC reports a minimum CDU detection limit of 0.07 μg/l using a modified method based on Pruszkowska et al. (1983). No CV is stated in this protocol; the protocol contains only rejection criteria for internal QC parameters used during accuracy determinations with known standards (Attachment 8 of exhibit 106 of OSHA docket H057A). Stoeppler and Brandt (1980) report a CDU detection limit of 0.2 μg/l for their methodology.

5.2.6 General Method Performance. For any particular method, the expected initial performance from commercial laboratories may be somewhat lower than that reported by the research laboratory in which the method was developed. With participation in appropriate proficiency programs, and use of a proper in-house QA/QC program incorporating provisions for regular corrective actions, the performance of commercial laboratories may be expected to improve and approach that reported by a research laboratories. The results reported for existing proficiency programs serve to specify the initial level of performance that likely can be expected from commercial laboratories offering analysis using a particular method.

Weber (1988) reports on the results of the CTQ proficiency program, which includes CDU results for laboratories participating in the program. Results indicate that after receiving 60 samples (i.e., after participating in the program for approximately 3 years), approximately 80% of the participating laboratories report CDU results ranging between ±2 μg/l or 15% of the consensus mean, whichever is greater. On any single sample of the last 15 samples, the proportion of laboratories falling within the specified range is between 75 and 95%, except for a single test for which only 60% of the laboratories reported acceptable results. For each of the last 15 samples, approximately 60% of the laboratories reported results within ±1 μg or 15% of the mean, whichever is greater. The range of concentrations included in this set of samples was not reported.

Another report from the CTQ (1991) summarizes preliminary CDU results from their 1991 interlaboratory program. According to the report, for 3 CDU samples with values of 9.0, 16.8, 31.5 μg/l, acceptable results (target ±2 μg/l or 15% of the consensus mean, whichever is greater) were achieved by only 44-52% of the 34 laboratories participating in the CDU program. The overall CVs for these 3 CDU samples among the 34 participating laboratories were 31%, 25%, and 49%, respectively. The reason for this poor performance has not been determined.

A more recent report from the CTQ (Weber, private communication) indicates that 36% of the laboratories in the program have been able to achieve the target of ±1 μg/l or 15% for more than 75% of the samples analyzed over the last 5 years, while 45% of participating laboratories achieved a target of ±2 μg/l or 15% for more than 75% of the samples analyzed over the same period.

Note that results reported in the interlaboratory programs are in terms of μg Cd/l of urine, unadjusted for creatinine. The performance indicated, therefore, is a measure of the performance of the cadmium portion of the analyses, and does not include variation that may be introduced during the analysis of CRTU.

5.2.7 Observed CDU Concentrations. Prior to the onset of renal dysfunction, CDU concentrations provide a general indication of the exposure history (i.e., body burden) (see Section 4.3). Once renal dysfunction occurs, CDU levels appear to increase and are no longer indicative solely of cadmium body burden (Friberg and Elinder 1988).

5.2.7.1 Range of CDU Concentrations Observed Among Unexposed Samples

Surveys of CDU concentrations in the general population were first reported from cooperative studies among industrial countries (i.e., Japan, U.S. and Sweden) conducted in the mid-1970s. In summarizing these data, Kjellstrom (1979) reported that CDU concentrations among Dallas, Texas men (age range: <9-59 years; smokers and nonsmokers) varied from 0.11-1.12 μg/l (uncorrected for creatinine or specific gravity). These CDU concentrations are intermediate between population values found in Sweden (range: 0.11-0.80 μg/l) and Japan (range: 0.14-2.32 μg/l).

Kowal and Zirkes (1983) reported CDU concentrations for almost 1,000 samples collected during 1978-79 from the general U.S. adult population (i.e., nine states; both genders; ages 20-74 years). They report that CDU concentrations are lognormally distributed; low levels predominated, but a small proportion of the population exhibited high levels. These investigators transformed the CDU concentrations values, and reported the same data 3 different ways: μg/l urine (unadjusted), μg/l (specific gravity adjusted to 1.020), and μg/g CRTU. These data are summarized in Tables 6 and 7.

Based on further statistical examination of these data, including the lifestyle characteristics of this group, Kowal

Table 6. Urine Cadmium Concentrations in the U.S. Adult Population: Normal and Concentration-Adjusted Values By Age and Sex[1]

	Geometric means (and geometric standard deviations)		
	Unadjusted (μg/l)	SG-adjusted (μg/l at 1.020)[2]	Creatine-adjusted (μg/g)
Sex:			
Male (n=484)	0.55 (2.9)	0.73 (2.6)	0.55 (2.7)
Female (n=498)	0.49 (3.0)	0.86 (2.7)	0.78 (2.7)
Age:			
20-29 (n=222)	0.32 (3.0)	0.43 (2.7)	0.32 (2.7)
30-39 (n=141)	0.46 (3.2)	0.70 (2.8)	0.54 (2.7)
40-49 (n=142)	0.50 (3.0)	0.81 (2.6)	0.70 (2.7)
50-59 (n=117)	0.61 (2.9)	0.99 (2.4)	0.90 (2.3)
60-69 (n=272)	0.76 (2.6)	1.16 (2.3)	1.03 (2.3)

[1] From Kowal and Zirkes 1983. [2] SC-adjusted is adjusted for specific gravity.

Table 7. Urine Cadmium Concentrations in the U.S. Adult Population: Cumulative Frequency Distribution of Urinary Cadmium (N=982)[1]
[In percentage]

Range of concentrations	Unadjusted (μg/l)	SG-adjusted (μg/l at 1.020)	Creatine-adjusted (μg/g)
<0.5	43.9	28.0	35.8
0.6-1.0	71.7	56.4	65.6
1.1-1.5	84.4	74.9	81.4
1.6-2.0	91.3	84.7	88.9
2.1-3.0	97.3	94.4	95.8
3.1-4.0	98.8	97.4	97.2
4.1-5.0	99.4	98.2	97.9
5.1-10.0	99.6	99.4	99.3
10.0-20.0	99.8	99.6	99.6

[1] Source: Kowal and Zirkes (1983).

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Table 8. Urine Cadmium Concentration in Workers Exposed to Cadmium in the Workplace

Study No.	Work environment (worker population monitored)	No. in study	Employment in years (mean)	Mean concentration of cadmium in air (μg/m³)	Arithmetic mean (±S.D)[b]	Absolute range or (95% CI)[c]	Geometric mean (±GSD)[d]	Lower 95th percentile of range[f]	Upper 95th percentile of range[f]	Reference
1	Ni-Cd battery plant and Cd production plant:		3-40	≤90						Lauwerys et al. 1976.
	(Workers without kidney lesions)	96			16.3±16.7			(0)	(44)	
	(Workers with kidney lesions)	25			48.2±q42.6			(0)	(120)	
2	Ni-Cd battery plant:									Adamsson et al. (1979)
	(Smokers)	7	(5)	10.1	5.5	1.0-14.7				
	(Non-smokers)	8	(9)	7.0	3.6	0.5-9.3				
3	Cadmium salts production facility	148	(15.4)		15.8	2-150				Butchet et al. 1980
4	Retrospective study of workers with renal problems:	19	15-41							Roels et al. 1982
	(Before removal)		(27.2)		39.4±28.1	10.8-117		(0)	(88)	
	(After removal)		(4.2)[g]		16.4±9.0	80-42.3		(1.0)	(32)	
5	Cadmium production plant:									Ellis et al. 1983
	(Workers without renal dysfunction)	33	1-34		9.4±6.9	2-27		(0)	(21)	
	(Workers with renal dysfunction)	18	10-34		22.8±12.7	8-55		(1)	(45)	
6	Cd-Cu alloy plant	75	Up to 39	Note h	6.9±9.4			(0)	(23)	Mason et al. 1988
7	Cadmium recovery operation	45	(19)	87	9.3±6.9			0	21	Thun et al. 1989
8	Pigment manufacturing plant	26	(12.8)	0.18-3.0		0.2-9.5	1.1			Mueller et al. 1989
9	Pigment manufacturing plant	26	(12.1)	≤3.0			1.25±2.45	0.3	6	Kawada et al. 1990

(1988) suggested increased cadmium absorption (i.e., body burden) was correlated with low dietary intakes of calcium and iron, as well as cigarette smoking.

CDU levels presented in Table 6 are adjusted for age and gender. Results suggest that CDU levels may be slightly different among men and women (i.e., higher among men when values are unadjusted, but lower among men when the values are adjusted, for specific gravity or CRTU). Mean differences among men and women are small compared to the standard deviations, and therefore may not be significant. Levels of CDU also appear to increase with age. The data in Table 6 suggest as well that reporting CDU levels adjusted for specific gravity or as a function of CRTU results in reduced variability.

The data in the Table 6 indicate the geometric mean of CDU levels observed among the general population is 0.52 μg Cd/l urine (unadjusted), with a geometric standard deviation of 3.0. Normalized for creatinine, the geometric mean for the population is 0.66 μg/g CRTU, with a geometric standard deviation of 2.7. Table 7 provides the distributions of CDU concentrations for the general population studied by Kowal and Zirkes. The data in this table indicate that 95% of the CDU levels observed among those not occupationally exposed to cadmium are below 3 μg/g CRTU.

5.2.7.2 Range of CDU Concentrations Observed Among Exposed Workers.

Table 8 is a summary of results from available studies of CDU concentrations observed among cadmium-exposed workers. In this table, arithmetic and/or geometric means and standard deviations are provided if reported in these studies. The absolute range for the data in each study, or the 95% confidence interval around the mean of each study, also are provided when reported. The lower and upper 95th percentile of the distribution are presented for each study in which a mean and corresponding standard deviation were reported. Table 8 also provides estimates of the years of exposure, and the levels of exposure, to cadmium in the work place if reported in these studies. Concentrations reported in this table are in μg/g CRTU, unless otherwise stated.

Data in Table 8 from Lauwerys et al. (1976) and Ellis et al. (1983) indicate that CDU concentrations are higher among those exhibiting kidney lesions or dysfunction than among those lacking these symptoms. Data from the study by Roels et al. (1982) indicate that CDU levels decrease among workers removed from occupational exposure to cadmium in comparison to workers experiencing ongoing exposure. In both cases, however, the distinction between the 2 groups is not as clear as with CDB; there is more overlap in CDU levels observed among each of the paired populations than is true for corresponding CDB levels. As with CDB levels, the data in Table 8 suggest increased CDU concentrations among workers who experienced increased overall exposure.

Although a few occupationally-exposed workers in the studies presented in Table 8 exhibit CDU levels below 3 μg/g CRTU, most of those workers exposed to cadmium levels in excess of the PEL defined in the final cadmium rule exhibit CDU levels above 3 μg/g CRTU; this level represents the upper 95th percentile of the CDU distribution observed among those who are not occupationally exposed to cadmium (Table 7).

The mean CDU levels reported in Table 8 among occupationally- exposed groups studied (except 2) exceed 3 μg/g CRTU. Correspondingly, the level of exposure reported in these studies (with 1 exception) are significantly higher than what workers will experience under the final cadmium rule. The 2 exceptions are from the studies by Mueller et al. (1989) and Kawada et al. (1990); these studies indicate that workers exposed to cadmium during pigment manufacture do not exhibit CDU levels as high as those levels observed among workers exposed to cadmium in other occupations. Exposure levels, however, were lower in the pigment manufacturing plants studied. Significantly, workers removed from occupational cadmium exposure for an average of 4 years still exhibited CDU levels in excess of 3 μg/g CRTU (Roels et al. 1982). In the single-exception study with a reported level of cadmium exposure lower than levels proposed in the final rule (i.e., the study of a pigment manufacturing plant by Kawada et al. 1990), most of the workers exhibited CDU levels less than 3 μg/g CRTU (i.e., the mean value was only 1.3 μg/g CRTU). CDU levels among workers with such limited cadmium exposure are expected to be significantly lower than levels reported on Table 8.

Based on the above data, a CDU level of 3 μg/g CRTU appear to represent a threshold above which significant work place exposure to cadmium occurs over the work span of those being monitored. Note that this threshold is not as distinct as the corresponding threshold described for CDB. In general, the variability associated with CDU measurements among exposed workers appears to be higher than the variability associated with CDB measurements among similar workers.

5.2.8 Conclusions and Recommendations for CDU.

The above evaluation supports the following recommendations for a CDU proficiency program. These recommendations address only sampling and analysis procedures for CDU determinations specifically, which are to be reported as an unadjusted μg Cd/l urine. Normalizing this result to creatinine requires a second analysis for CRTU so that the ratio of the 2 measurements can be obtained. Creatinine analysis is addressed in Section 5.4. Formal procedures for combining the 2 measurements to derive a value and a confidence limit for CDU in μg/g CRTU are provided in Section 3.3.3.

5.2.8.1 Recommended Method.

The method of Pruszkowska et al. (1983) should be adopted for CDU analysis. This method is recommended because it is simple, straightforward and reliable (i.e., small variations in experimental conditions do not affect the analytical results).

A synopsis of the methods used by laboratories to determine CDU under the interlaboratory program administered by the CTQ (1991) indicates that more than 78% (24 of 31) of the participating laboratories use a dilution method to prepare urine samples for CDU analysis. Laboratories may adopt alternate methods, but it is the responsibility of the laboratory to demonstrate that the alternate methods provide results of comparable quality to the Pruszkowska method.

5.2.8.2 Data Quality Objectives.

The following data quality objectives should facilitate interpretation of analytical results, and are achievable based on the above evaluation.

Limit of Detection. A level of 0.5 μg/l (i.e., corresponding to a detection limit of 0.5 μg/g CRTU, assuming 1 g CRT/l urine) should be achievable. Pruszkowska et al. (1983) achieved a limit of detection of 0.04 μg/l for CDU based on the slope the the curve for their working standards (0.35 pg Cd/0.0044, A signal=1% absorbance using GF-AAS).

The CDC reports a minimum detection limit for CDU of 0.07 μg/l using a modified Pruszkowska method. This limit of detection was defined as 3 times the standard deviation calculated from 10 repeated measurements of a "low level" CDU test sample (Attachment 8 of exhibit 106 of OSHA docket H057A).

Stoeppler and Brandt (1980) report a limit of detection for CDU of 0.2 μg/l using an aqueous dilution (1:2) of the urine samples.

Accuracy. A recent report from the CTQ (Weber, private communication) indicates that 36% of the laboratories in the program achieve the target of ±1 μg/l or 15% for more than 75% of the samples analyzed over the last 5 years, while 45% of participating laboratories achieve a tar-

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get of ±2 μg/l or 15% for more than 75% of the samples analyzed over the same period. With time and a strong incentive for improvement, it is expected that the proportion of laboratories successfully achieving the stricter level of accuracy should increase. It should be noted, however, these indices of performance do not include variations resulting from the ancillary measurement of CRTU (which is recommended for the proper recording of results). The low cadmium levels expected to be measured indicate that the analysis of creatinine will contribute relatively little to the overall variability observed among creatinine-normalized CDU levels (see Section 5.4). The initial target value for reporting CDU under this program, therefore, is set at ±1 μg/g CRTU or 15% (whichever is greater).

Precision. For internal QC samples (which are recommended as part of an internal QA/QC program, Section 3.3.1), laboratories should attain an overall precision of 25%. For CDB samples with concentrations less than 2 μg/l, a target precision of 40% is acceptable, while precisions of 20% should be achievable for CDU concentrations greater than 2 μg/l. Although these values are more stringent than those observed in the CTQ interlaboratory program reported by Webber (1988), they are well within limits expected to be achievable for the method as reported by Stoeppler and Brandt (1980).

5.2.8.3 Quality Assurance/Quality Control.

Commercial laboratories providing CDU determinations should adopt an internal QA/QC program that incorporates the following components: Strict adherence to the selected method, including calibration requirements; regular incorporation of QC samples during actual runs; a protocol for corrective actions, and documentation of such actions; and, participation in an interlaboratory proficiency program. Note that the nonmandatory program presented in Attachment 1 as an example of an acceptable QA/QC program, is based on using the Pruszkowska method for CDU analysis. Should an alternate method be adopted by a laboratory, the laboratory should develop a QA/QC program equivalent to the nonmandatory program, and which satisfies the provisions of Section 3.3.1.

5.3 Monitoring β-2-Microglobulin in Urine (B_2MU).

As indicated in Section 4.3, B_2MU appears to be the best of several small proteins that may be monitored as early indicators of cadmium-induced renal damage. Several analytic techniques are available for measuring B_2M.

5.3.1 Units of B_2MU Measurement.

Procedures adopted for reporting B_2MU levels are not uniform. In these guidelines, OSHA recommends that B_2MU levels be reported as μg/g CRTU, similar to reporting CDU concentrations. Reporting B_2MU normalized to the concentration of CRTU requires an additional analytical process beyond the analysis of B_2M: Independent analysis for creatinine so that results may be reported as a ratio of the B_2M and creatinine concentrations found in the urine sample. Consequently, the overall quality of the analysis depends on the combined performance on these 2 analyses. The analysis used for B_2MU determinations is described in terms of μg B_2M/l urine, with analysis of creatinine addressed separately. Techniques used to measure creatinine are provided in Section 5.4. Note that Section 3.3.3 provides techniques for deriving the value of B_2M as function of CRTU, and the confidence limits for independent measurements of B_2M and CRTU.

5.3.2 Analytical Techniques Used to Monitor B_2MU.

One of the earliest tests used to measure B_2MU was the radial immunodiffusion technique. This technique is a simple and specific method for identification and quantitation of a number of proteins found in human serum and other body fluids when the protein is not readily differentiated by standard electrophoretic procedures. A quantitative relationship exists between the concentration of a protein deposited in a well that is cut into a thin agarose layer containing the corresponding monospecific antiserum, and the distance that the resultant complex diffuses. The wells are filled with an unknown serum and the standard (or control), and incubated in a moist environment at room temperature. After the optimal point of diffusion has been reached, the diameters of the resulting precipitation rings are measured. The diameter of a ring is related to the concentration of the constituent substance. For B_2MU determinations required in the medical monitoring program, this method requires a process that may be insufficient to concentrate the protein to levels that are required for detection.

Radioimmunoassay (RIA) techniques are used widely in immunologic assays to measure the concentration of antigen or antibody in body-fluid samples. RIA procedures are based on competitive- binding techniques. If antigen concentration is being measured, the principle underlying the procedure is that radioactive-labeled antigen competes with the sample's unlabeled antigen for binding sites on a known amount of immobile antibody. When these 3 components are present in the system, an equilibrium exists. This equilibrium is followed by a separation of the free and bound forms of the antigen. Either free or bound radioactive-labeled antigen can be assessed to determine the amount of antigen in the sample. The analysis is performed by measuring the level of radiation emitted either by the bound complex following removal of the solution containing the free antigen, or by the isolated solution containing the residual-free antigen. The main advantage of the RIA method is the extreme sensitivity of detection for emitted radiation and the corresponding ability to detect trace amounts of antigen. Additionally, large numbers of tests can be performed rapidly.

The enzyme-linked immunosorbent assay (ELISA) techniques are similar to RIA techniques except that nonradioactive labels are employed. This technique is safe, specific and rapid, and is nearly as sensitive as RIA techniques. An enzyme-labeled antigen is used in the immunologic assay; the labeled antigen detects the presence and quantity of unlabeled antigen in the sample. In a representative ELISA test, a plastic plate is coated with antibody (e.g., antibody to B_2M). The antibody reacts with antigen (B_2M) in the urine and forms an antigen-antibody complex on the plate. A second anti-B_2M antibody (i.e., labeled with an enzyme) is added to the mixture and forms an antibody-antigen- antibody complex. Enzyme activity is measured spectrophotometrically after the addition of a specific chromogenic substrate which is activated by the bound enzyme. The results of a typical test are calculated by comparing the spectrophotometric reading of a serum sample to that of a control or reference serum. In general, these procedures are faster and require less laboratory work than other methods.

In a fluorescent ELISA technique (such as the one employed in the Pharmacia Delphia test for B_2M), the labeled enzyme is bound to a strong fluorescent dye. In the Pharmacia Delphia test, an antigen bound to a fluorescent dye competes with unlabeled antigen in the sample for a predetermined amount of specific, immobile antibody. Once equilibrium is reached, the immobile phase is removed from the labeled antigen in the sample solution and washed; an enhancement solution then is added that liberates the fluorescent dye from the bound antigen-antibody complex. The enhancement solution also contains a chelate that complexes with the fluorescent dye in solution; this complex increases the fluorescent properties of the dye so that it is easier to detect.

To determine the quantity of B_2M in a sample using the Pharmacia Delphia test, the intensity of the fluorescence of the enhancement solution is measured. This

intensity is proportional to the concentration of labeled antigen that bound to the immobile antibody phase during the initial competition with unlabeled antigen from the sample. Consequently, the intensity of the fluorescence is an inverse function of the concentration of antigen (B_2M) in the original sample. The relationship between the fluorescence level and the B_2M concentration in the sample is determined using a series of graded standards, and extrapolating these standards to find the concentration of the unknown sample.

5.3.3 Methods Developed for B_2MU Determinations.

B_2MU usually is measured by radioimmunoassay (RIA) or enzyme- linked immunosorbent assay (ELISA); however, other methods (including gel electrophoresis, radial immunodiffusion, and nephelometric assays) also have been described (Schardun and van Epps 1987). RIA and ELISA methods are preferred because they are sensitive at concentrations as low as micrograms per liter, require no concentration processes, are highly reliable and use only a small sample volume.

Based on a survey of the literature, the ELISA technique is recommended for monitoring B_2MU. While RIAs provide greater sensitivity (typically about 1 μg/l, Evrin et al. 1971), they depend on the use of radioisotopes; use of radioisotopes requires adherence to rules and regulations established by the Atomic Energy Commission, and necessitates an expensive radioactivity counter for testing. Radioisotopes also have a relatively short half-life, which corresponds to a reduced shelf life, thereby increasing the cost and complexity of testing. In contrast, ELISA testing can be performed on routine laboratory spectrophotometers, do not necessitate adherence to additional rules and regulations governing the handling of radioactive substances, and the test kits have long shelf lives. Further, the range of sensitivity commonly achieved by the recommended ELISA test (i.e., the Pharmacia Delphia test) is approximately 100 μg/l (Pharmacia 1990), which is sufficient for monitoring B_2MU levels resulting from cadmium exposure. Based on the studies listed in Table 7 (Section 5.3.7), the average range of B_2M concentrations among the general, nonexposed population falls between 60 and 300 μg/g CRTU. The upper 95th percentile of distributions, derived from studies in Table 9 which reported standard deviations, range between 180 and 1,140 μg/g CRTU. Also, the Pharmacia Delphia test currently is the most widely used test for assessing B_2MU.

5.3.4 Sample Collection and Handling.

As with CDB or CDU, sample collection procedures are addressed primarily to identify ways to minimize the degree of variability introduced by sample collection during medical monitoring. It is unclear the extent to which sample collection contributes to B_2MU variability. Sources of variation include time-of-day effects, the interval since consuming liquids and the quantity of liquids consumed, and the introduction of external contamination during the collection process. A special problem unique to B_2M sampling is the sensitivity of this protein to degradation under acid conditions commonly found in the bladder. To minimize this problem, strict adherence to a sampling protocol is recommended. The protocol should include provisions for normalizing the conditions under which the urine is collected. Clearly, it is important to minimize the interval urine spends in the bladder. It also is recommended that every effort be made to collect samples during the same time of day.

Collection of urine samples for biological monitoring usually is performed using "spot" (i.e., single-void) urine. Logistics and sample integrity become problems when efforts are made to collect urine over extended periods (e.g., 24 hrs). Unless single- void urines are used, numerous opportunities exist for measurement error because of poor control over sample collection, storage and environmental contamination.

To minimize the interval that sample urine resides in the bladder, the following adaption to the "spot" collection procedure is recommended: The bladder should be emptied and then a large glass of water should be consumed; the sample then should be collected within an hour after the water is consumed.

5.3.5 Best Achievable Performance.

The best achievable performance is assumed to be equivalent to the performance reported by the manufacturers of the Pharmacia Delphia test kits (Pharmacia 1990). According to the insert that comes with these kits, QC results should be within ±2 SDs of the mean for each control sample tested; a CV of less than or equal to 5.2% should be maintained. The total CV reported for test kits is less than or equal to 7.2%.

5.3.6 General Method Performance.

Unlike analyses for CDB and CDU, the Pharmacia Delphia test is standardized in a commercial kit that controls for many sources of variation. In the absence of data to the contrary, it is assumed that the achievable performance reported by the manufacturer of this test kit will serve as an achievable performance objective. The CTQ proficiency testing program for B_2MU analysis is expected to use the performance parameters defined by the test kit manufacturer as the basis of the B_2MU proficiency testing program.

Note that results reported for the test kit are expressed in terms of μg B_2M/l of urine, and have not been adjusted for creatinine. The indicated performance, therefore, is a measure of the performance of the B_2M portion of the analyses only, and does not include variation that may have been introduced during the analysis of creatinine.

5.3.7 Observed B_2MU Concentrations.

As indicated in Section 4.3, the concentration of B_2MU may serve as an early indicator of the onset of kidney damage associated with cadmium exposure.

5.3.7.1 Range of B_2MU Concentrations Among Unexposed Samples.

Most of the studies listed in Table 9 report B_2MU levels for those who were not occupationally exposed to cadmium. Studies noted in the second column of this table (which contain the footnote "d") reported B_2MU concentrations among cadmium-exposed workers who, nonetheless, showed no signs of proteinuria. These latter studies are included in this table because, as indicated in Section 4.3, monitoring B_2MU is intended to provide advanced warning of the onset of kidney dysfunction associated with cadmium exposure, rather than to distinguish relative exposure. This table, therefore, indicates the range of B_2MU levels observed among those who had no symptoms of renal dysfunction (including cadmium -exposed workers with none of these symptoms).

To the extent possible, the studies listed in Table 9 provide geometric means and geometric standard deviations for measurements among the groups defined in each study. For studies reporting a geometric standard deviation along with a mean, the lower and upper 95th percentile for these distributions were derived and reported in the table.

The data provided from 15 of the 19 studies listed in Table 9 indicate that the geometric mean concentration of B_2M observed among those who were not occupationally exposed to cadmium is 70-170 μg/g CRTU. Data from the 4 remaining studies indicate that exposed workers who exhibit no signs of proteinuria show mean B_2MU levels of 60-300 μg/g CRTU. B_2MU values in the study by Thun et al. (1989), however, appear high in comparison to the other 3 studies. If this study is removed, B_2MU levels for those who are not occupationally exposed to cadmium are similar to B_2MU levels found among cadmium-exposed workers who exhibit no signs of kidney dysfunction. Although the mean is high in the study by Thun et al., the range of measurements reported in this study is within the ranges reported for the other studies.

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Table 9. B-2-Microglobulin Concentrations Observed in Urine Among Those Not Occupationally Exposed to Cadmium

Study No.	No. in study	Geometric mean	Geometric standard deviation	Lower 95th percentile of distribution[a]	Upper 95th percentile of distribution[a]	Reference
1	133 m[b]	115 μg/g[c]	4.03	12	1,140 μg/g[c]	Ishizaki et al. 1989
2	161 f[b]	146 μg/g[c]	3.11	23	940 μg/g[c]	Ishizaki et al. 1989
3	10	84 μg/g				Ellis et al. 1983
4	203	76 μg/l				Stewart and Hughes 1981
5	9	103 μg/g				Chia et al. 1989
6	47[d]	86 μg/L	1.9	30 μg/l	250 μg/L	Kjellstrom et al. 1977
7	1,000[e]	68.1 μg/gr Cr[f]	3.1 m & f	<10 μg/gr Cr[h]	320 μg/gr Cr[h]	Kowal 1983
8	87	71 μg/g[i]		7[h]	200[h]	Buchet et al. 1980
9	10	0.073 mg/24[h]				Evrin et al. 1971
10	59	156 μg/g	1.1[j]	130	180	Mason et al. 1988
11	8	118 μg/g				Iwao et al. 1980
12	34	79 μg/g				Wibowo et al. 1982
13	41 m				400 μg/gr Cr[k]	Falck et al. 1983
14	35[n]	67				Roels et al. 1991
15	31[d]	63				Roels et al. 1991
16	36[d]	77[i]				Miksche et al. 1981
17	18[n]	130				Kawada et al. 1989
18	32[p]	122				Kawada et al. 1989
19	18[d]	295	1.4	170	510	Thun et al. 1989

Determining a reasonable upper limit from the range of B_2M concentrations observed among those who do not exhibit signs of proteinuria is problematic. Elevated B_2MU levels are among the signs used to define the onset of kidney dysfunction. Without access to the raw data from the studies listed in Table 9, it is necessary to rely on reported standard deviations to estimate an upper limit for normal B_2MU concentrations (i.e., the upper 95th percentile for the distributions measured). For the 8 studies reporting a geometric standard deviation, the upper 95th percentiles for the distributions are 180-1140 μg/g CRTU. These values are in general agreement with the upper 95th percentile for the distribution (i.e., 631 μg/g CRTU) reported by Buchet et al. (1980). These upper limits also appear to be in general agreement with B_2MU values (i.e., 100-690 μg/g CRTU) reported as the normal upper limit by Iwao et al. (1980), Kawada et al. (1989), Wibowo et al. (1982), and Schardun and van Epps (1987). These values must be compared to levels reported among those exhibiting kidney dysfunction to define a threshold level for kidney dysfunction related to cadmium exposure.

5.3.7.2 Range of B_2MU Concentrations Among Exposed Workers.

Table 10 presents results from studies reporting B_2MU determinations among those occupationally exposed to cadmium in the work place; in some of these studies, kidney dysfunction was observed among exposed workers, while other studies did not make an effort to distinguish among exposed workers based on kidney dysfunction. As with Table 9, this table provides geometric means and geometric standard deviations for the groups defined in each study if available. For studies reporting a geometric standard deviation along with a mean, the lower and upper 95th percentiles for the distributions are derived and reported in the table.

The data provided in Table 10 indicate that the mean B_2MU concentration observed among workers experiencing occupational exposure to cadmium (but with undefined levels of proteinuria) is 160-7400 μg/g CRTU. One of these studies reports geometric means lower than this range (i.e., as low as 71 μg/g CRTU); an explanation for this wide spread in average concentrations is not available.

Seven of the studies listed in Table 10 report a range of B_2MU levels among those diagnosed as having renal dysfunction. As indicated in this table, renal dysfunction (proteinuria) is defined in several of these studies by B_2MU levels in excess of 300 μg/g CRTU (see footnote "c" of Table 10); therefore, the range of B_2MU levels observed in these studies is a function of the operational definition used to identify those with renal dysfunction. Nevertheless, a B_2MU level of 300 μg/g CRTU appears to be a meaningful threshold for identifying those having early signs of kidney damage. While levels much higher than 300 μg/g CRTU have been observed among those with renal dysfunction, the vast majority of those not occupationally exposed to cadmium exhibit much lower B_2MU concentrations (see Table 9). Similarly, the vast majority of workers not exhibiting renal dysfunction are found to have levels below 300 μg/g CRTU (Table 9).

The 300 μg/g CRTU level for B_2MU proposed in the above paragraph has support among researchers as the threshold level that distinguishes between cadmium-exposed workers with and without kidney dysfunction. For example, in the guide for physicians who must evaluate cadmium- exposed workers written for the Cadmium Council by Dr. Lauwerys, levels of B_2M greater than 200-300 μg/g CRTU are considered to require additional medical evaluation for kidney dysfunction (exhibit 8-447, OSHA docket H057A). The most widely used test for measuring B_2M (i.e., the Pharmacia Delphia test) defines B_2MU levels above 300 μg/l as abnormal (exhibit L-140-1, OSHA docket H057A).

Dr. Elinder, chairman of the Department of Nephrology at the Karolinska Institute, testified at the hearings on the proposed cadmium rule. According to Dr. Elinder (exhibit L-140-45, OSHA docket H057A), the normal concentration of B_2MU has been well documented (Evrin and Wibell 1972; Kjellstrom et al. 1977a; Elinder et al. 1978, 1983; Buchet et al. 1980; Jawaid et al. 1983; Kowal and Zirkes, 1983). Elinder stated that the upper 95 or 97.5 percentiles for B_2MU among those without tubular dysfunction is below 300 μg/g CRTU (Kjellstrom et al. 1977a; Buchet et al. 1980; Kowal and Zirkes, 1983). Elinder defined levels of B_2M above 300 μg/g CRTU as "slight" proteinuria.

5.3.8 Conclusions and Recommendations for B_2MU.

Based on the above evaluation, the following recommendations are made for a B_2MU proficiency testing program. Note that the following discussion addresses only sampling and analysis for B_2MU determinations (i.e., to be reported as an

Table 10. β_2-Microglobulin Concentrations Observed in Urine Among Occupationally-Exposed Workers

Study No.	No. in study	Concentration of β_2-Microglobulin in urine				Reference
		Geometric mean (μg/g)	Geometric Standard Deviation	Lower 95% of range	Upper 95% of range	
1	1,424	160	6.19	8.1	3,300	Ishizaki et al. 1989
2	1,754	260	6.50	12	5,600	Ishizaki et al. 1989
3	33	210				Ellis et al. 1983
4	65	210				Chia et al. 1989
5	[c]44	5,700	6.49	[d]300	[d]98,000	Kjellstrom et al. 1977
6	148	[e]180		[f]110	[f]280	Buchet et al. 1980
7	[c]37	160	3.90	17	1,500	Kenzaburo et al. 1979
8	[c]45	3,300	8.70	[d]310	[d]89,000	Mason et al. 1988
9	[c]10	6,100	5.99	[f]650	[f]57,000	Falck et al. 1983
10	11	3,900	2.96	[d]710	[d]15,000	Elinder et al. 1985
11	[c]12	300				Roelset al. 1991
12	[g]8	7,400				Roels et al. 1991
13	[c]23	[h]1,800				Roels et al. 1989
14	10	690				Iwao et al. 1980
15	34	71				Wibowo et al. 1982
16	[c]15	4,700	6.49	[d]590	[d]93,000	Thun et al. 1989

[a] Unless otherwise stated
[b] Based on an assumed lognormal distribution.
[c] Among workers diagnosed as having renal dysfunction; for Elinder this means β_2 levels greater than 300 micrograms per gram creatinine (μg/gr Cr); for Roels, 1991, range=31-35, 170 μgβ_2/gr Cr and geometric mean=63 among healthy workers; for Mason β_2>300 μg/gr Cr.
[d] Based on a detailed review of the data by OSHA.
[e] Arithmetic mean.
[f] Reported in the study.
[g] Retired workers.
[h] 1,800 μgβ_2/gr Cr for first survey; second survey=1,600; third survey=2,600; fourth survey=2,600; fifth survey=2,600.

unadjusted μg B_2M/l urine). Normalizing this result to creatinine requires a second analysis for CRTU (see section 5.4) so that the ratio of the 2 measurements can be obtained.

5.3.8.1 Recommended Method.

The Pharmacia Delphia method (Pharmacia 1990) should be adopted as the standard method for B_2MU determinations. Laboratories may adopt alternate methods, but it is the responsibility of the laboratory to demonstrate that alternate methods provide results of comparable quality to the Pharmacia Delphia method.

5.3.8.2 Data Quality Objectives.

The following data quality objectives should facilitate interpretation of analytical results, and should be achievable based on the above evaluation.

Limit of Detection. A limit of 100 μg/l urine should be achievable, although the insert to the test kit (Pharmacia 1990) cites a detection limit of 150 μg/l; private conversations with representatives of Pharmacia, however, indicate that the lower limit of 100 μg/l should be achievable provided an additional standard of 100 μg/l B_2M is run with the other standards to derive the calibration curve (section 3.3.1.1). The lower detection limit is desirable due to the proximity of this detection limit to B_2MU values defined for the cadmium medical monitoring program.

Accuracy. Because results from an interlaboratory proficiency testing program are not available currently, it is difficult to define an achievable level of accuracy. Given the general performance parameters defined by the insert to the test kits, however, an accuracy of ±15% of the target value appears achievable.

Due to the low levels of B_2MU to be measured generally, it is anticipated that the analysis of creatinine will contribute relatively little to the overall variability observed among creatinine-normalized B_2MU levels (see section 5.4). The initial level of accuracy for reporting B_2MU levels under this program should be set at ±15%.

Precision. Based on precision data reported by Pharmacia (1990), a precision value (i.e., CV) of 5% should be achievable over the defined range of the analyte. For internal QC samples (i.e., recommended as part of an internal QA/QC program, section 3.3.1), laboratories should attain precision near 5% over the range of concentrations measured.

5.3.8.3 Quality Assurance/Quality Control.

Commercial laboratories providing measurement of B_2MU should adopt an internal QA/QC program that incorporates the following components: Strict adherence to the Pharmacia Delphia method, including calibration requirements; regular use of QC samples during routine runs; a protocol for corrective actions, and documentation of these actions; and, participation in an interlaboratory proficiency program. Procedures that may be used to address internal QC requirements are presented in Attachment 1. Due to differences between analyses for B_2MU and CDB/CDU, specific values presented in Attachment 1 may have to be modified. Other components of the program (including characterization runs), however, can be adapted to a program for B_2MU.

5.4 Monitoring Creatinine in Urine (CRTU).

Because CDU and B_2MU should be reported relative to concentrations of CRTU, these concentrations should be determined in addition CDU and B_2MU determinations.

5.4.1 Units of CRTU Measurement.

CDU should be reported as μg Cd/g CRTU, while B_2MU should be reported as μg B_2M/g CRTU. To derive the ratio of cadmium or B_2M to creatinine, CRTU should be reported in units of g crtn/l of urine. Depending on the analytical method, it may be necessary to convert results of creatinine determinations accordingly.

5.4.2 Analytical Techniques Used To Monitor CRTU.

Of the techniques available for CRTU determinations, an absorbance spec-

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trophotometric technique and a high-performance liquid chromatography (HPLC) technique are identified as acceptable in this protocol.

5.4.3 Methods Developed for CRTU Determinations.

CRTU analysis performed in support of either CDU or B_2MU determinations should be performed using either of the following 2 methods:

1. The Du Pont method (i.e., Jaffe method), in which creatinine in a sample reacts with picrate under alkaline conditions, and the resulting red chromofore is monitored (at 510 nm) for a fixed interval to determine the rate of the reaction; this reaction rate is proportional to the concentration of creatinine present in the sample (a copy of this method is provided in Attachment 2 of this protocol); or.

2. The OSHA SLC Technical Center (OSLTC) method, in which creatinine in an aliquot of sample is separated using an HPLC column equipped with a UV detector; the resulting peak is quantified using an electrical integrator (a copy of this method is provided in Attachment 3 of this protocol).

5.4.4 Sample Collection and Handling.

CRTU samples should be segregated from samples collected for CDU or B_2MU analysis. Sample-collection techniques have been described under section 5.2.4. Samples should be preserved either to stabilize CDU (with HNO_3) or B_2MU (with NaOH). Neither of these procedures should adversely affect CRTU analysis (see Attachment 3).

5.4.5 General Method Performance.

Data from the OSLTC indicate that a CV of 5% should be achievable using the OSLTC method (Septon, L private communication). The achievable accuracy of this method has not been determined.

Results reported in surveys conducted by the CAP (CAP 1991a, 1991b and 1992) indicate that a CV of 5% is achievable. The accuracy achievable for CRTU determinations has not been reported.

Laboratories performing creatinine analysis under this protocol should be CAP accredited and should be active participants in the CAP surveys.

5.4.6 Observed CRTU Concentrations.

Published data suggest the range of CRTU concentrations is 1.0-1.6 g in 24-hour urine samples (Harrison 1987). These values are equivalent to about 1 g/l urine.

5.4.7 Conclusions and Recommendations for CRTU

5.4.7.1 Recommended Method.

Use either the Jaffe method (Attachment 2) or the OSLTC method (Attachment 3). Alternate methods may be acceptable provided adequate performance is demonstrated in the CAP program.

5.4.7.2 Data Quality Objectives.

Limit of Detection. This value has not been formally defined; however, a value of 0.1 g/l urine should be readily achievable.

Accuracy. This value has not been defined formally; accuracy should be sufficient to retain accreditation from the CAP.

Precision. A CV of 5% should be achievable using the recommended methods.

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Attachment 1-Nonmandatory Protocol for an Internal Quality Assurance/Quality Control Program.

The following is an example of the type of internal quality assurance/quality control program that assures adequate control to satisfy OSHA requirements under this protocol. However, other approaches may also be acceptable.

As indicated in Section 3.3.1 of the protocol, the QA/QC program for CDB and CDU should address, at a minimum, the following:

- Calibration;.
- Establishment of control limits;
- Internal QC analyses and maintaining control; and
- Corrective action protocols.

This illustrative program includes both initial characterization runs to establish the performance of the method and ongoing analysis of quality control samples intermixed with compliance samples to maintain control.

Calibration.

Before any analytical runs are conducted, the analytic instrument must be calibrated. This is to be done at the beginning of each day on which quality control samples and/or compliance samples are run. Once calibration is established, quality control samples or compliance samples may be run. Regardless of the type of samples run, every fifth sample must be a standard to assure that the calibration is holding.

Calibration is defined as holding if every standard is within plus or minus (±) 15% of its theoretical value. If a standard is more than plus or minus 15% of its theoretical value, then the run is out of control due to calibration error and the entire set of samples must either be

reanalyzed after recalibrating or results should be recalculated based on a statistical curve derived from the measurement of all standards.

It is essential that the highest standard run is higher than the highest sample run. To assure that this is the case, it may be necessary to run a high standard at the end of the run, which is selected based on the results obtained over the course of the run.

All standards should be kept fresh, and as they get old, they should be compared with new standards and replaced.

Initial Characterization Runs and Establishing Control.

A participating laboratory should establish four pools of quality control samples for each of the analytes for which it wishes to be accredited. The concentrations of quality control samples within each pool are to be centered around each of the four target levels for the particular analyte identified in Section 4.4 of the protocol.

Within each pool, at least 4 quality control samples need to be established with varying concentrations ranging between plus or minus 50% of the target value of that pool. Thus for the medium-high cadmium in blood pool, the theoretical values of the quality control samples may range from 5 to 15 μg/l, (the target value is 10 μg/l). At least 4 unique theoretical values must be represented in this pool.

The range of theoretical values of plus or minus 50% of the target value of a pool means that there will be overlap of the pools. For example, the range of values for the medium-low pool for cadmium in blood is 3.5 to 10.5 μg/l while the range of values for the medium-high pool is 5 to 15 μg/l. Therefore, it is possible for a quality control sample from the medium- low pool to have a higher concentration of cadmium than a quality control sample from the medium-high pool.

Quality control samples may be obtained as commercially available reference materials, internally prepared, or both. Internally prepared samples should be well characterized and traced or compared to a reference material for which a consensus value for concentration is available. Levels of analyte in the quality control samples must be concealed from the analyst prior to the reporting of analytical results. Potential sources of materials that may be used to construct quality control samples are listed in Section 3.3.1 of the protocol.

Before any compliance samples are analyzed, control limits must be established. Control limits should be calculated for every pool of each analyte for which determinations will be made and control charts should be kept for each pool or each analyte. A separate set of control charts and control limits should be established for each analytical instrument in a laboratory that will be used for analysis of compliance samples.

At the beginning of this QA/QC program, control limits should be based on the results of the analysis of 20 quality control samples from each pool of each analyte. For any given pool, the 20 quality control samples should be run on 20 different days. Although no more than one sample should be run from any single pool on a particular day, a laboratory may run quality control samples from different pools on the same day. This constitutes a set of initial characterization runs.

For each quality control sample analyzed, the value F/T (defined in the glossary) should be calculated. To calculate the control limits for a pool of an analyte, it is first necessary to calculate the mean, $\overline{X}$, of the F/T values for each quality control sample in a pool and then to calculate its standard deviation, σ. Thus, for the control limit for a pool, $\overline{X}$ is calculated as:

$$\frac{(\Sigma\ F/T)}{N}$$

and σ is calculated as

$$\left[\frac{\Sigma\ (F/T-\overline{X})^2}{n-1}\right]^{1/2}$$

where N is the number of quality control samples run for a pool.

The control limit for a particular pool is then given by the mean plus or minus 3 standard deviations ($\overline{X} \pm 3\sigma$). The control limits may be no greater than 40% of the mean F/T value. If three standard deviations are greater than 40% of the mean F/T value, then analysis of compliance samples may not begin.[1] Instead, an investigation into the causes of the large standard deviation should begin, and the inadequacies must be remedied. Then, control limits must be reestablished which will mean repeating the running 20 quality control samples from each pool over 20 days.

Internal Quality Control Analyses and Maintaining Control.

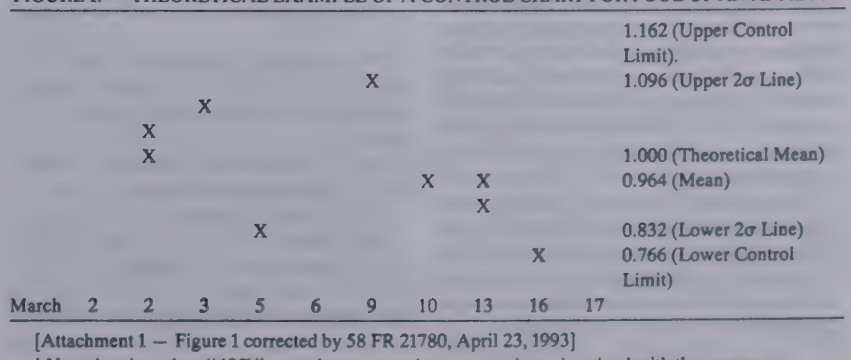
Once control limits have been established for each pool of an analyte, analysis of compliance samples may begin. During any run of compliance samples, quality control samples are to be interspersed at a rate of no less than 5% of the compliance sample workload. When quality control samples are run, however, they should be run in sets consisting of one quality control sample from each pool. Therefore, it may be necessary, at times, to intersperse quality control samples at a rate greater than 5%.

There should be at least one set of quality control samples run with any analysis of compliance samples. At a minimum, for example, 4 quality control samples should be run even if only 1 compliance sample is run. Generally, the number of quality control samples that should be run are a multiple of four with the minimum equal to the smallest multiple of four that is greater than 5% of the total number of samples to be run. For example, if 300 compliance samples of an analyte are run, then at least 16 quality control samples should be run (16 is the smallest multiple of four that is greater than 15, which is 5% of 300).

Control charts for each pool of an analyte (and for each instrument in the laboratory to be used for analysis of compliance samples) should be established by plotting F/T versus date as the quality control sample results are reported. On the graph there should be lines representing the control limits for the pool, the mean F/T limits for the pool, and the theoretical F/T of 1.000. Lines representing plus or minus (±) 2σ should also be represented on the charts. A theoretical example of a control chart is presented in Figure 1.

All quality control samples should be plotted on the chart, and the charts should be checked for visual trends. If a quality control sample falls above or below the control limits for its pool, then corrective steps must be taken (see the section on corrective actions below). Once a labora-

FIGURE 1. — THEORETICAL EXAMPLE OF A CONTROL CHART FOR POOL OF AN ANALYTE



[Attachment 1 — Figure 1 corrected by 58 FR 21780, April 23, 1993]

[1] Note that the value, "40%" may change over time as experience is gained with the program.

tory's program has been established, control limits should be updated every 2 months, prior to sending OSHA the updated data required to maintain accreditation.

The updated control limits should be calculated from the results of the last 100 quality control samples run for each pool. If 100 quality control samples from a pool have not been run at the time of the update, then the limits should be based on as many as have been run provided at least 20 quality control samples from each pool have been run over 20 different days.

The trends that should be looked for on the control charts are:

1. 10 consecutive quality control samples falling above or below the mean;.
2. 3 consecutive quality control samples falling more than 2 from the mean (above or below the 2 lines of the chart); or.
3. the mean calculated to update the control limits falls more than 10% above or below the theoretical mean of 1.000.

If any of these trends is observed, then all analysis must be stopped, and an investigation into the causes of the errors must begin. Before the analysis of compliance samples may resume, the inadequacies must be remedied and the control limits must be reestablished for that pool of an analyte. Reestablishment of control limits will entail running 20 sets of quality control samples over 20 days.

Note that alternative procedures for defining internal quality control limits may also be acceptable. Limits may be based, for example, on proficiency testing, such as ± 1 μg or 15% of the mean (whichever is greater). These should be clearly defined.

Corrective Actions.

Corrective action is the term used to describe the identification and remediation of errors occurring within an analysis. Corrective action is necessary whenever the result of the analysis of any quality control sample falls outside of the established control limits. The steps involved may include simple things like checking calculations of basic instrument maintenance, or it may involve more complicated actions like major instrument repair. Whatever the source of error, it must be identified and corrected (and a Corrective Action Report (CAR) must be completed and sent to OSHA with the next reaccreditation).

To maintain accreditation, laboratories must report corrective actions to the OSHA Salt Lake Technical Center. A form to be used for reporting corrective actions is provided in Attachment 5 of the protocol.

Attachment 2.

Creatinine in Urine (JAFFE PROCEDURE).

Intended Use: The CREA pack is used in the Du Pont ACA® discrete clinical analyzer to quantitatively measure creatinine in serum and urine.

Summary The CREA method employs a modification of the kinetic Jaffe reaction reported by Larsen. This method has been reported to be less susceptible than conventional methods to interference from non-creatinine, Jaffe-positive compounds.[1]

A split sample comparison between the CREA method and a conventional Jaffe procedure on Autoanalyzer® showed a good correlation. (See Specific Performance Characteristics).

Autoanalyzer® is a registered trademark of Technicon Corp., Tarrytown, NY.

Principles of Procedure: In the presence of a strong base such as NaOH, picrate reacts with creatinine to form a red chromophore. The rate of increasing absorbance at 510 nm due to the formation of this chromophore during a 17.07-second measurement period is directly proportional to the creatinine concentration in the sample.

$$\text{Creatinine} + \text{Picrate} \xrightarrow{\text{NaOH}} \text{Red chromophore (absorbs at 510 nm)}$$

Reagents:

Compartment[a]	Form	Ingredient	Quantity[b]
No. 2, 3, & 4	Liquid	Picrate	0.11 mmol
No. 6	Liquid	NaOH (for pH adjustment)[c]	

[a] Compartments are numbered 1-7, with compartment No. 7 located closest to pack fill position No. 2.
[b] Nominal value at manufacture.
[c] See Precautions.

Precautions: Compartment No. 6 contains 75μL of 10 N NaOH; avoid contact; skin irritant; rinse contacted area with water.

Used packs contain human body fluids; handle with appropriate care.

For In Vitro Diagnostic Use.

Mixing and Diluting: Mixing and diluting are automatically performed by the ACA® discrete clinical analyzer. The sample cup must contain sufficient quantity to accommodate the sample volume plus the "dead volume"; precise cup filling is not required.

Sample Cup Volumes (μL)

Analyzer	Standard		Microsystem	
	Dead	Total	Dead	Total
II, III	120	3000	10	500
IV, SX	120	3000	30	500
V	90	3000	10	500

Storage of Unprocessed Packs: Store at 2-8 °C. Do not freeze. Do not expose to temperatures above 35 °C or to direct sunlight.

Expiration: Refer to expiration date on the tray label.

Specimen Collection: Serum or urine can be collected and stored by normal procedures.[2].

Known Interfering Substances:[3] Serum Protein Influence. Serum protein levels exert a direct influence on the CREA assay. The following should be taken into account when this method is used for urine samples and when it is calibrated:

Aqueous creatinine standards or urine specimens will give CREA results depressed by approximately 0.7 mg/dL [62 μmol/L][d] and will be less precise than samples containing more than 3 g/dL [30 g/L] protein.

All urine specimens should be diluted with an albumin solution to give a final protein concentration of at least 3 g/dL [30 g/L]. Du Pont Enzyme Diluent (Cat. #790035-901) may be used for this purpose.

- High concentration of endrogenous bilirubin (>20 mg/dL [>342 μmol/L]) will give depressed CREA results (average depression 0.8 mg/dL [71 μmol/L]).[4]
- Grossly hemolyzed (hemoglobin >100 mg/dL [>62 μmol/L]) or visibly lipemic specimens may cause falsely elevated CREA results.[5,6]
- The following cephalosporin antibiotics do not interfere with the CREA method when present at the concentrations indicated. Systematic inaccuracies (bias) due to these substances are less than or equal to 0.1 mg/dL [8.84 μmol/L] at CREA concentrations of approximately 1 mg/dL [88 μmol/L].

Systeme International d'unites (S.I. Units) are in brackets.

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Antibiotic	Peak serum level[7,8,9]	Drug concentration		
	mg/dL	[mmol/L]	mg/dL	[mmol/L]
Cephaloridine	1.4	0.3	25	6.0
Cephalexin	0.6-2.0	0.2-0.6	25	7.2
Cephamandole	1.3-2.5	0.3-0.5	25	4.9
Cephapirin	2.0	0.4	25	5.6
Cephradine	1.5-2.0	0.4-0.6	25	7.1
Cefazolin	2.5-5.0	0.55-1.1	50	11.0

[Table corrected by 58 FR 21780, April 23, 1991]

• The following cephalosporin antibiotics have been shown to affect CREA results when present at the indicated concentrations. System inaccuracies (bias) due to these substances are greater that 0.1 mg/dL [8.84 μmol/L] at CREA concentrations of:

Antibiotic	Peak serum level[8,10]	Drug concentration		
	mg/dl	mg/dL[mmol/L]	mg/dL[mmol/L]	effect percent
Cephalothin	1-6	0.2-1.5	10025.2	20-25
Cephoxitin	2.0	0.5	5.01.2	35-40

[Table corrected by 58 FR 21780, April 23, 1993]

• The single wavelength measurement used in this method eliminates interference from chromophores whose 510 nm absorbance is constant throughout the measurement period.

• Each laboratory should determine the acceptability of its own blood collection tubes and serum separation products. Variations in these products may exist between manufacturers and, at times, from lot to lot.

Procedure

Test Materials

Item	II, III, Du Pont cat. No.	IV, SX, Du Pont cat. No.	V, Du Pont cat. No.
ACA® CREA analytical test pack	701976901	701976901	701976901
Sample system kit,	710642901	710642901	713697901
or			
Micro sample system kit,	702694901	710356901	NA
and			
Micro sample system holders	702785000	NA	NA
DYLUX® photosensitive printer paper	700036000	NA	NA
Thermal printer paper	NA	710639901	713645901
Du Pont purified water	704209901	710615901	710815901
Cell wash solution	701864901	710664901	710864901

[Table corrected by 58 FR 21780, April 23, 1993]

Test Steps.

The operator need only load the sample kit and appropriate test pack(s) into a properly prepared ACA® discrete clinical analyzer. It automatically advances the pack(s) through the test steps and prints a result(s). See the Instrument Manual of the ACA® analyzer for details of mechanical travel of the test pack(s).

Preset Creatinine (CREA) Test Conditions.

- Sample volume: 200 μL.
- Diluent: purified water.
- Temperature: 37.0 ± 0.1 °C.
- Reaction period: 29 seconds.
- Type of measurement: rate.
- Measurement period: 17.07 seconds.
- Wavelength: 510 nm.
- Units: mg/dL [μmol/L].

Calibration.

The general calibration procedure is described in the Calibration/Verification chapter of the Manuals.

The following information should be considered when calibrating the CREA method.

- Assay range: 0-20 mg/mL [0-1768 μmol/L][e]
- Reference material: Protein containing primary standards[f] or secondary calibrators such as Du Pont Elevated Chemistry Control (Cat. #790035903) and Normal Chemistry Control (Cat. #790035905)[g]
- Suggested calibration levels: 1,5,20, mg/mL, [88, 442, 1768 μmol/L].
- Calibration scheme: 3 levels, 3 packs per level.
- Frequency: Each new pack lot. Every 3 months for any one pack lot.

e. For the results in S.I. units [μmol/L] the conversion factor is 88.4.

f. Refer to the Creatinine Standard Preparation and Calibration Procedure available on request from a Du Pont Representative.

g. If the Du Pont Chemistry Controls are being used, prepare them according to the instructions on the product insert sheets.

Preset Creatinine (CREA) Test Conditions

Item	ACA®, II, analyzer	ACA®, III, IV, SX, V, analyzer
Count by	One (1) [Five (5)	NA
Decimal point	0.0mg/dL	000.0 mg/dL
Location	[000.μmol/L]	[000 μmol/L].
Assigned starting.	999.8	-1.000 E1
Point or offset C_o	[9823.]	[-8.840 E2]
Scale factor or.	0.2000	2.004 E-1[h]
assigned	mg/dL/count[h]	
Linear term C_1[h]	[0.3536μmol/L/count]	[1.772E1]

h. The preset scale factor (linear term) was derived from the molar absorptivity of the indicator and is based on an absorbance to activity relationship (sensitivity) of 0.596 (mA/min)/(U/L). Due to small differences in filters and electronic components between instruments, the actual scale factor (linear term) may differ slightly from that given above.

Quality Control.

Two types of quality control procedures are recommended:

- General instrument check. Refer to the Filter Balance Procedure and the Absorbance Test Method described in the Instrument Manual. Refer also to the ABS Test Methodology literature.
- Creatinine method check. At least once daily run a CREA test on a solution of known creatinine activity such as an assayed control or calibration standard other than that used to calibrate the CREA method. For further details review the Quality Assurance Section of the Chemistry Manual. The result obtained should fall within acceptable limits defined by the day-to-day variability of the system as measured in the user's laboratory. (See SPECIFIC PERFORMANCE CHARACTERISTICS for guidance.) If the result falls outside the laboratory's acceptable limits, follow the procedure outlined in the Chemistry Troubleshooting Section of the Chemistry Manual.

A possible system malfunction is indicated when analysis of a sample with five

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consecutive test packs gives the following results:

Level	SD
1 mg/dL [88 µmol/L]	>0.15 mg/dL [>13 µmol/L]
20 mg/dL [1768 µmol/L]	>0.68 mg/dL [>60 µmol/L].

Refer to the procedure outlined in the Trouble Shooting Section of the Manual.

Results.

The ACA® analyzer automatically calculates and prints the CREA result in mg/dL [µmol/L].

Limitation of Procedure.

Results >20 mg/dL [1768 µmol/L]:

- Dilute with suitable protein base diluent. Reassay. Correct for diluting before reporting.

The reporting system contains error messages to warn the operator of specific malfunctions. Any report slip containing a letter code or word immediately following the numerical value should not be reported. Refer to the Manual for the definition of error codes.

Reference Interval

Serum:[11,i] Males-0.8-1.3 md/dL [71-115 µmol/L].

Females: 0.6-1.0 md/dL [53-88 µmol/L]

Urine:[12] Males-0.6-2.5 g/24 hr [53-221 mmol/24 hr]

Females: 0.6-1.5 g/24 hr [53-133 mmol/24 hr]

Each laboratory should establish its own reference intervals for CREA as performed on the analyzer.

Reference interval data obtained from 200 apparently healthy individuals (71 males, 129 females) between the ages of 19 and 72.

Specific Performance Characteristics

Reproducibility[k]

Material	Mean	Standard deviation (% CV)	
		Within-run	Between-day
Lyophilized Control	1.3 [115]	0.05 (3.7) [4.4]	0.05 (3.7) [4.4]
Lyophilized Control	20.6 [1821]	0.12 (0.6) [10.6]	0.37 (1.8) [32.7]

j. ALL SPECIFIC PERFORMANCE CHARACTERISTICS tests were run after normal recommended equipment quality control checks were performed (see Instrument Manual).

Correlation-Regression Statistics[l]

Comparative method	Slope	Intercept	Correlation coefficient	n
Autoanalyzer®	1.03	0.03[2.7]	0.997	260

k. Specimens at each level were analyzed in duplicate for twenty days. The within-run and between-day standard deviations were calculated by the analysis of variance method.

l. Model equation for regression statistics is:

Result of ACA® Analyzer = Slope (Comparative method result) + intercept

Assay Range[m]

0.0-20.0 mg/dl [0-1768 µmol].

m. See REPRODUCIBILITY for method performance within the assay range.

Analytical Specificity

See KNOWN INTERFERING SUBSTANCES section for details.

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Attachment 3

Analysis of Creatinine for the Normalization of Cadmium and Beta-2-Microglobulin Concentrations in Urine

Matrix: Urine

Target Concentration: 1.1 g/L (this amount is representative of creatinine concentrations found in urine).

Procedure: A 1.0 mL aliquot of urine is passed through a C18 SEP-PAK® (Waters Associates). Approximately 30 mL of HPLC (high performance liquid chromatography) grade water is then run through the SEP-PAK. The resulting solution is diluted to volume in a 100-mL volumetric flask and analyzed by HPLC using an ultraviolet (UV) detector.

Special Requirements: After collection, samples should be appropriately stabilized for cadmium (Cd) analysis by using 10% high purity (with low Cd background levels) nitric acid (exactly 1.0 mL of 10% nitric acid per 10 mL of urine) or stabilized for Beta-2-Microglobulin (B_2M) by taking to pH 7 with dilute NaOH (exactly 1.0 mL of 0.11 N NaOH per 10 mL of urine) If not immediately analyzed, the samples should be frozen and shipped by overnight mail in an insulated container.

Date: January 1992.

Chemists: David B. Armitage, Duane Lee,

Organic Service Branch II, OSHA Technical Center, Salt Lake City, Utah.

1. General Discussion

1.1. Background

1.1.1. History of procedure

Creatinine has been analyzed by several methods in the past The earliest methods were of the wet chemical type. As an example, creatinine reacts with sodium picrate in basic solution to form a red complex, which is then analyzed colorimetrically (Refs. 5.1. and 5.2.).

Since industrial hygiene laboratories will be analyzing for Cd and B_2M in urine, they will be normalizing those concentrations to the concentration of creatinine in urine. A literature search revealed several HPLC methods (Refs. 5.3., 5.4., 5.5. and 5.6.) for creatinine in urine and because

many industrial hygiene laboratories have HPLC equipment, it was desirable to develop an industrial hygiene HPLC method for creatinine in urine. The method of Hausen, Fuchs, and Wachter was chosen as the starting point for method development SEP-PAKs were used for sample clarification and cleanup in this method to protect the analytical column. The urine aliquot which has been passed through the SEP-PAK is then analyzed by reverse-phase HPLC using ion-pair techniques.

This method is very similar to that of Ogata and Taguchi (Ref 5.6.), except they used centrifugation for sample clean- up. It is also of note that they did a comparison of their HPLC results to those of the Jaffe method (a picric acid method commonly used in the health care industry) and found a linear relationship of close to 1:1. This indicates that either HPLC or colorimetric methods may be used to measure creatinine concentrations in urine.

1.1.2. Physical properties (Ref. 5.7.)

Molecular weight: 113.12

Molecular formula: C_4-H_7-N_3-O

Chemical name: 2-amino-1,5-dihydro-1-methyl-4H-imidazol-4-one

CAS#: 60-27-5

Melting point: 300 °C (decomposes)

Appearance: white powder

Solubility: soluble in water; slightly soluble in alcohol; practically insoluble in acetone, ether, and chloroform

Synonyms: 1-methylglycocyamidine, 1-methylhydation-2-imide

Structure: see Figure #1

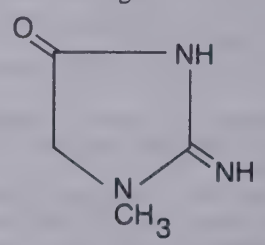

Figure 1

1.2 Advantages

1.2.1. This method offers a simple, straightforward, and specific alternative method to the Jaffe method.

1.2.2. HPLC instrumentation is commonly found in many industrial hygiene laboratories.

2. Sample Stabilization Procedure

2.1. Apparatus

Metal-free plastic container for urine sample.

2.2. Reagents

2.2.1. Stabilizing Solution-1) Nitric acid (10%, high purity with low Cd background levels) for stabilizing urine for Cd analysis or 2) NaOH, 0.11 N, for stabilizing urine for B_2M analysis.

2.2.2. HPLC grade water

2.3. Technique

2.3.1. Stabilizing solution is added to the urine sample (see section 2.2.1.). The stabilizing solution should be such that for each 10 mL of urine, add exactly 1.0 mL of stabilizer solution. (Never add water or urine to acid or base. Always add acid or base to water or urine.) Exactly 1.0 mL of 0.11 N NaOH added to 10 mL of urine should result in a pH of 7. Or add 1.0 mL of 10% nitric acid to 10 mL of urine.

2.3.2. After sample collection seal the plastic bottle securely and wrap it with an appropriate seal. Urine samples should be frozen and then shipped by overnight mail (if shipping is necessary) in an insulated container. (Do not fill plastic bottle too full. This will allow for expansion of contents during the freezing process.)

2.4. The Effect of Preparation and Stabilization Techniques on Creatinine Concentrations

Three urine samples were prepared by making one sample acidic, not treating a second sample, and adjusting a third sample to pH 7. The samples were analyzed in duplicate by two different procedures. For the first procedure a 1.0 mL aliquot of urine was put in a 100-mL volumetric flask, diluted to volume with HPLC grade water, and then analyzed directly on an HPLC. The other procedure used SEP-PAKs. The SEP-PAK was rinsed with approximately 5 mL of methanol followed by approximately 10 mL of HPLC grade water and both rinses were discarded Then, 1.0 mL of the urine sample was put through the SEP- PAK, followed by 30 mL of HPLC grade water. The urine and water were transferred to a 100-mL volumetric flask, diluted to volume with HPLC grade water, and analyzed by HPLC. These three urine samples were analyzed on the day they were obtained and then frozen. The results show that whether the urine is acidic, untreated or adjusted to pH 7, the resulting answer for creatinine is essentially unchanged. The purpose of stabilizing the urine by making it acidic or neutral is for the analysis of Cd or B_2M respectively.

Comparison of Preparation and Stabilization Technique

Sample	w/o SEP-PAK (g/L creatine)	with SEP-PAK (g/L creatinine)
Acid	1.10	1.10
Acid	1.11	1.10
Untreated	1.12	1.11
Untreated	1.11	1.12
pH7	1.08	1.02
pH7	1.11	1.08

2.5. Storage.

After 4 days and 54 days of storage in a freezer, the samples were thawed, brought to room temperature and analyzed using the same procedures as in section 2.4. The results of several days of storage show that the resulting answer for creatinine is essentially unchanged.

2.6. Interferences.

None.

2.7. Safety precautions

2.7.1. Make sure samples are properly sealed and frozen before shipment to avoid leakage.

2.7.2. Follow the appropriate shipping procedures.

The following modified special safety precautions are based on those recommended by the Centers for Disease Control (CDC)(Ref. 5.8.).

2.7.3. Wear gloves, lab coat, and safety glasses while handling all human urine products. Disposable plastic, glass, and paper (pipet tips, gloves, etc.) that contact urine should be placed in a biohazard autoclave bag. These bags should be kept in appropriate containers until sealed and autoclaved Wipe down all work surfaces with 10% sodium hypochlorite solution when work is finished.

2.7.4. Dispose of all biological samples and diluted specimens in a biohazard autoclave bag at the end of the analytical run.

2.7.5. Special care should be taken when handling and dispensing nitric acid. Always remember to add acid to water (or urine) Nitric acid is a corrosive chemical capable of severe eye and skin damage. Wear metal-free gloves, a lab coat, and safety glasses. If the nitric acid comes in contact with any part of the body, quickly wash with copious quantities of water for at least 15 minutes.

2.7.6. Special care should be taken when handling and dispensing NaOH. Always remember to add base to water (or urine). NaOH can cause severe eye and skin damage. Always wear the appropriate gloves, a lab coat, and safety glasses. If the NaOH comes in contact with any part of the body, quickly wash with copious quantities of water for at least 15 minutes.

3. Analytical Procedure

3.1 Apparatus

3.1.1 A high performance liquid chromatograph equipped with pump, sample injector and UV detector.

3.1.2 A C18 HPLC column; 25 cm × 4.6 mm I.D.

3.1.3 An electronic integrator, or some other suitable means of determining analyte response.

3.1.4 Stripchart recorder.

3.1.5 C18 SEP-PAKs (Waters Associates) or equivalent.

3.1.6 Luer-lock syringe for sample preparation (5 mL or 10 mL).

3.1.7 Volumetric pipettes and flasks for standard and sample preparation.

Z

Storage Data

Sample	4 days w/o SEP-PAK (g/L creatinine)	4 days with SEP-PAK (g/L creatinine)	54 days w/o SEP-PAK (g/L creatinine)	54 days with SEP-PAK (g/L creatinine)
Acid	1.09	1.09	1.08	1.09
Acid	1.10	1.10	1.09	1.10
Acid			1.09	1.09
Untreated	1.13	1.14	1.09	1.11
Untreated	1.15	1.14	1.10	1.10
Untreated			1.09	1.10
pH 7	1.14	1.13	1.12	1.12
pH 7	1.14	1.13	1.12	1.12
pH 7			1.12	1.12

3.1.8 Vacuum system to aid sample preparation (optional).
3.2. Reagents
3.2.1 Water, HPLC grade.
3.2.2 Methanol, HPLC grade.
3.2.3 PIC B-7® (Waters Associates) in small vials.
3.2.4 Creatinine, anhydrous, Sigma Chemical Corp., purity not listed.
3.2.5 1-Heptanesulfonic acid, sodium salt monohydrate.
3.2.6 Phosphoric acid.
3.2.7 Mobile phase. It can be prepared by mixing one vial of PIC B-7 into a 1 L solution of 50% methanol and 50% water The mobile phase can also be made by preparing a solution that is 50% methanol and 50% water with 0.005M heptanesulfonic acid and adjusting the pH of the solution to 3.5 with phosphoric acid.
3.3 Standard preparation
3.3.1 Stock standards were prepared by weighing 10 to 15 mg of creatinine. This is transferred to a 25-mL volumetric flask and diluted to volume with HPLC grade water.
3.3.2 Dilutions to a working range of 3 to 35 μg/mL are made in either HPLC grade water or HPLC mobile phase (standards give the same detector response in either solution).
3.4 Sample preparation
3.4.1 The C18 SEP-PAK is connected to a Luer-lock syringe It is rinsed with 5 mL HPLC grade methanol and then 10 mL of HPLC grade water. These rinses are discarded.
3.4.2 Exactly 1.0 mL of urine is pipetted into the syringe The urine is put through the SEP-PAK into a suitable container using a vacuum system.
3.4.3 The walls of the syringe are rinsed in several stages with a total of approximately 30 mL of HPLC grade water. These rinses are put through the SEP-PAK into the same container The resulting solution is transferred to a 100-mL volumetric flask and then brought to volume with HPLC grade water.
3.5 Analysis (conditions and hardware are those used in this evaluation.)
3.5.1 Instrument conditions
Column: Zorbax® ODS, 5-6 μm particle size; 25 cm × 4.6 mm I.D.
Mobile phase: See Section 3.2.7.
Detector: Dual wavelength UV; 229 nm (primary) 254 nm (secondary),
Flow rate: 0.7 mL/minute.
Retention time: 7.2 minutes.
Sensitivity: 0.05 AUFS.
Injection volume: 20 μL.
3.5.2 Chromatogram (See Figure #2).
3.6 Interferences
3.6.1 Any compound that has the same retention time as creatinine and absorbs at 229 nm is an interference.
3.6.2 HPLC conditions may be varied to circumvent interferences In addition, analysis at another UV wavelength (i.e. 254 nm) would allow a comparison of the ratio of response of a standard to that of a sample. Any deviations would indicate an interference.
3.7 Calculations
3.7.1 A calibration curve is constructed by plotting detector response versus standard concentration (See Figure #3).
3.7.2 The concentration of creatinine in a sample is determined by finding the concentration corresponding to its detector response. (See Figure #3).
3.7.3 The μg/mL creatinine from section 3.7.2. is then multiplied by 100 (the dilution factor). This value is equivalent to the micrograms of creatinine in the 1.0 mL stabilized urine aliquot or the milligrams of creatinine per liter of urine The desired unit, g/L, is determined by the following relationship:

$$g/L = \frac{\mu g/mL}{1000} = \frac{mg/L}{1000}$$

3.7.4 The resulting value for creatinine is used to normalize the uniary concentration of the desired analyte (A) (Cd or B_2M) by using the following formula:

$$\frac{\mu g\ A/g}{\text{creatinine}} = \frac{\mu g\ A/L\ \text{(experimental)}}{g/L\ \text{creatinine}}$$

Where A is the desired analyte. The protocol of reporting such normalized results is μg A/g creatinine.
3.8 Safety precautions. See section 2.7.
4. Conclusions
The determination of creatinine in urine by HPLC is a good alternative to the Jaffe method for industrial hygiene laboratories Sample clarification with SEP-PAKs did not change the amount of creatinine found in urine samples. However, it does protect the analytical column. The results of this creatinine in urine procedure are unaffected by the pH of the urine sample under the conditions tested by this procedure. Therefore, no special measures are required for creatinine analysis whether the urine sample has been stabilized with 10% nitric acid for the Cd analysis or brought to a pH of 7 with 0.11 NaOH for the B_2M analysis.
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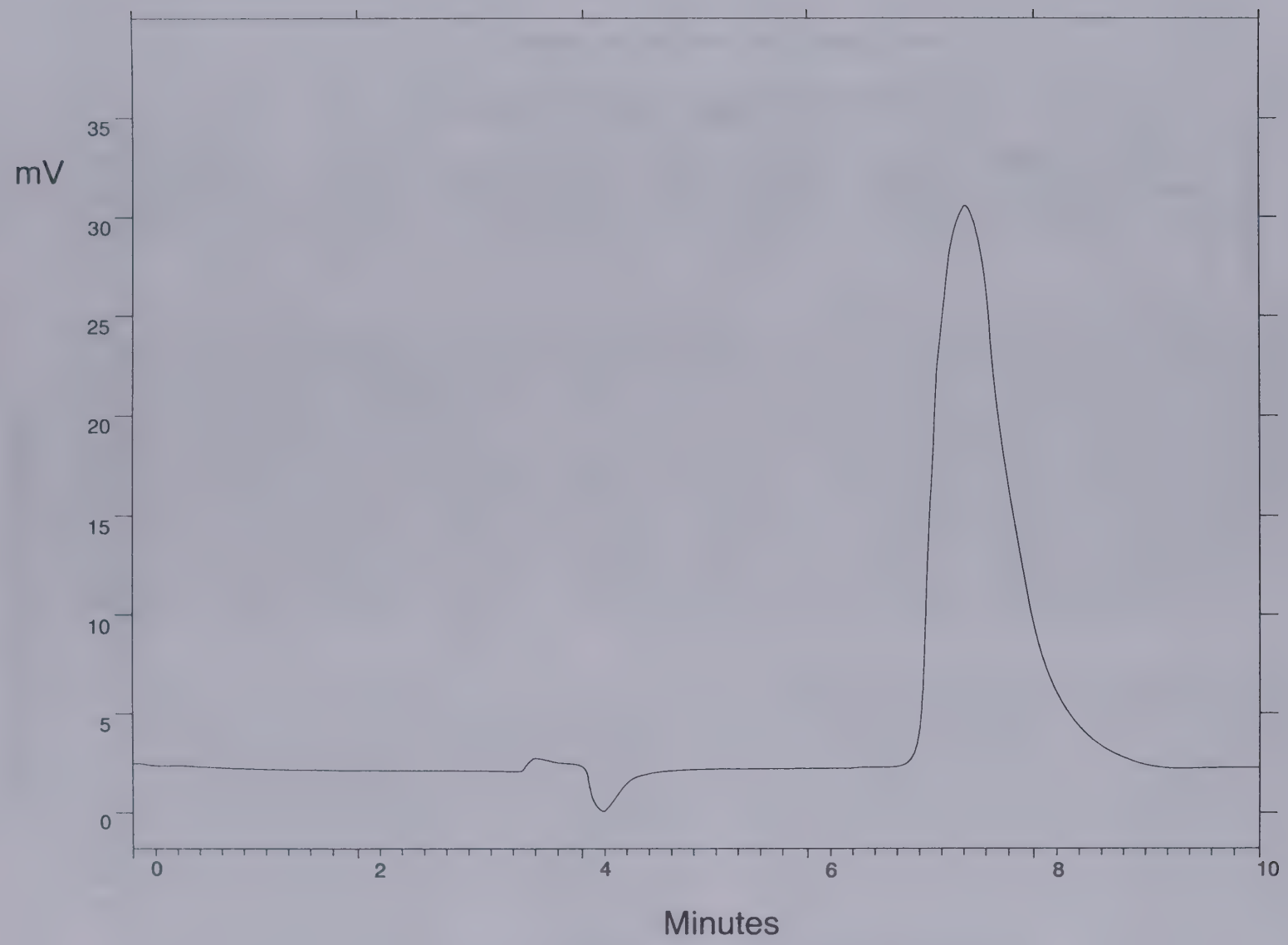
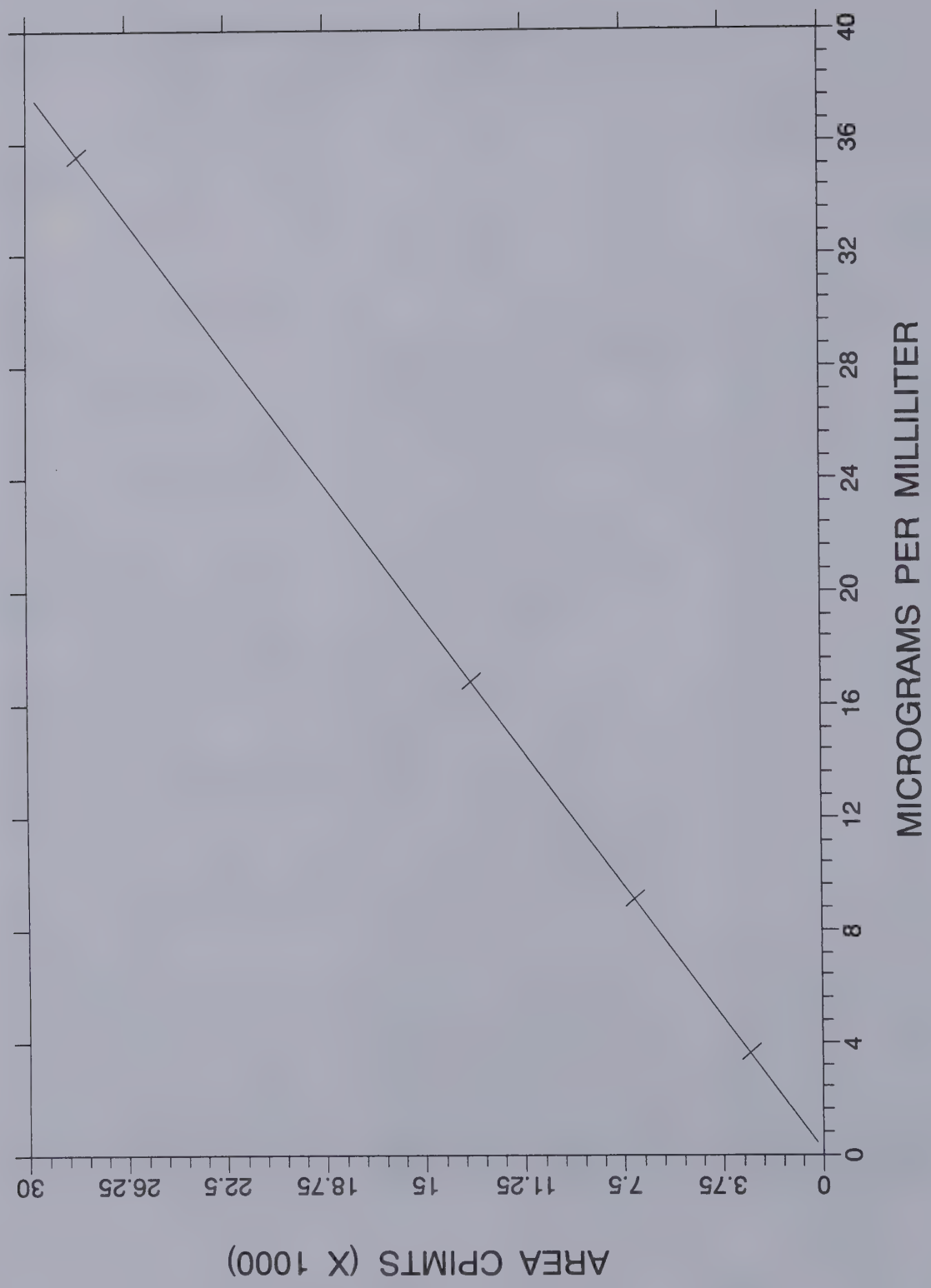


Chromatogram of a creatinine standard
Figure 2



Calibration curve for creatinine
Figure 3

Appendix A—Substance Safety Data Sheet, Benzene

I. Substance Identification

A. Substance: Benzene.

B. Permissible Exposure: Except as to the use of gasoline, motor fuels and other fuels subsequent to discharge from bulk terminals and other exemptions specified in § 1910.1028(a)(2):

1. Airborne: The maximum time-weighted average (TWA) exposure limit is 1 part of benzene vapor per million parts of air (1 ppm) for an 8-hour workday and the maximum short-term exposure limit (STEL) is 5 ppm for any 15-minute period.

2. Dermal: Eye contact shall be prevented and skin contact with liquid benzene shall be limited.

C. Appearance and odor: Benzene is a clear, colorless liquid with a pleasant, sweet odor. The odor of benzene does not provide adequate warning of its hazard.

II. Health Hazard Data

A. *Ways in which benzene affects your health.* Benzene can affect your health if you inhale it, or if it comes in contact with your skin or eyes. Benzene is also harmful if you happen to swallow it.

B. *Effects of overexposure.* 1. Short-term (acute) overexposure: If you are overexposed to high concentrations of benzene, well above the levels where its odor is first recognizable, you may feel breathless, irritable, euphoric, or giddy; you may experience irritation in eyes, nose, and respiratory tract. You may develop a headache, feel dizzy, nauseated, or intoxicated. Severe exposures may lead to convulsions and loss of consciousness.

2. Long-term (chronic) exposure. Repeated or prolonged exposure to benzene, even at relatively low concentrations, may result in various blood disorders, ranging from anemia to leukemia, an irreversible, fatal disease. Many blood disorders associated with benzene exposure may occur without symptoms.

III. Protective Clothing and Equipment

A. *Respirators.* Respirators are required for those operations in which engineering controls or work practice controls are not feasible to reduce exposure to the permissible level. However, where employers can document that benzene is present in the workplace less than 30 days a year, respirators may be used in lieu of engineering controls. If respirators are worn, they must have joint Mine Safety and Health Administration and the National Institute for Occupational Safety and Health (NIOSH) seal of approval, and cartridge or canisters must be replaced before the end of their service life, or the end of the shift, whichever occurs first. If you experience difficulty breathing while wearing a respirator, you may request a positive pressure respirator from your employer. You must be thoroughly trained to use the assigned respirator, and the training will be provided by your employer.

B. *Protective Clothing.* You must wear appropriate protective clothing (such as boots, gloves, sleeves, aprons, etc.) over any parts of your body that could be exposed to liquid benzene.

C. *Eye and Face Protection.* You must wear splash-proof safety goggles if it is possible that benzene may get into your eyes. In addition, you must wear a face shield if your face could be splashed with benzene liquid.

IV. Emergency and First Aid Procedures

A. *Eye and face exposure.* If benzene is splashed in your eyes, wash it out immediately with large amounts of water. If irritation persists or vision appears to be affected see a doctor as soon as possible.

B. *Skin exposure.* If benzene is spilled on your clothing or skin, remove the contaminated clothing and wash the exposed skin with large amounts of water and soap immediately. Wash contaminated clothing before you wear it again.

C. *Breathing.* If you or any other person breathes in large amounts of benzene, get the exposed person to fresh air at once. Apply artificial respiration if breathing has stopped. Call for medical assistance or a doctor as soon as possible. Never enter any vessel or confined space where the benzene concentration might be high without proper safety equipment and at least one other person present who will stay outside. A life line should be used.

D. *Swallowing.* If benzene has been swallowed and the patient is conscious, do not induce vomiting. Call for medical assistance or a doctor immediately.

V. Medical Requirements

If you are exposed to benzene at a concentration at or above 0.5 ppm as an 8-hour time-weighted average, or have been exposed at or above 10 ppm in the past while employed by your current employer, your employer is required to provide a medical examination and history and laboratory tests within 60 days of the effective date of this standard and annually thereafter. These tests shall be provided without cost to you. In addition, if you are accidentally exposed to benzene (either by ingestion, inhalation, or skin/eye contact) under emergency conditions known or suspected to constitute toxic exposure to benzene, your employer is required to make special laboratory tests available to you.

VI. Observation of Monitoring

Your employer is required to perform measurements that are representative of your exposure to benzene and you or your designated representative are entitled to observe the monitoring procedure. You are entitled to observe the steps taken in the measurement procedure, and to record the results obtained. When the monitoring procedure is taking place in an area where respirators or personal protective clothing and equipment are required to be worn, you or your representative must also be provided with, and must wear the protective clothing and equipment.

VII. Access to Records

You or your representative are entitled to see the records of measurements of your exposure to benzene upon written request to your employer. Your medical examination records can be furnished to yourself, your physician or designated representative upon request by you to your employer.

VIII. Precautions for Safe Use, Handling and Storage

Benzene liquid is highly flammable. It should be stored in tightly closed containers in a cool, well ventilated area. Benzene vapor may form explosive mixtures in air. All sources of ignition must be controlled. Use nonsparking tools when opening or closing benzene containers. Fire extinguishers, where provided, must be readily available. Know where they are located and how to operate them. Smoking is prohibited in areas where benzene is used or stored. Ask your supervisor where benzene is used in your area and for additional plant safety rules.

Appendix B—Substance Technical Guidlines, Benzene

I. Physical and Chemical Data

A. Substance identification.

1. *Synonyms:* Benzol, benzole, coal naphtha, cyclohexatriene, phene, phenyl hydride, pyrobenzol. (Benzin, petroleum benzin and Benzine do not contain benzene).

2. *Formula:* C_6H_6 (CAS Registry Number: 71–43–2)

B. Physical data.

1. Boiling Point (760 mm Hg): 80.1 °C (176 °F)

2. Specific Gravity (water=1): 0.879

3. Vapor Density (air=1): 2.7

4. Melting Point: 5.5 °C (42 °F)

5. Vapor Pressure at 20 °C (68 °F): 75 mm Hg

6. Solubility in Water: .06%

7. Evaporation Rate (ether=1): 2.8

8. Appearance and Odor: Clear, colorless liquid with a distinctive sweet odor.

II. Fire, Explosion, and Reactivity Hazard Data

A. Fire.

1. Flash Point (closed cup): −11 °C (12 °F)

2. Autoignition Temperature: 580 °C (1076 °F)

3. Flammable limits in Air. % by Volume: Lower: 1.3%, Upper: 7.5%

4. Extinguishing Media: Carbon dioxide, dry chemical, or foam.

5. Special Fire-Fighting procedures: Do not use solid stream of water. since stream will scatter and spread fire. Fine water spray can be used to keep fire-exposed containers cool.

6. Unusual fire and explosion hazards: Benzene is a flammable liquid. Its vapors can form explosive mixtures. All ignition sources must be controlled when benzene is used, handled, or stored. Where liquid or vapor may be released, such areas shall be considered as hazardous locations. Benzene vapors are heavier than air; thus the vapors may travel along the ground and be ignited by open flames or sparks at locations remote from the site at which benzene is handled.

7. Benzene is classified as a 1 B flammable liquid for the purpose of conforming to the requirements of 29 CFR 1910.106. A concentration exceeding 3,250 ppm is considered a potential fire explosion hazard. Locations where benzene may be present in quantities sufficient to produce explosive or ignitable mixtures are considered Class I Group D for the purposes of conforming to the requirements of 29 CFR 1910.309.

B. Reactivity.

1. Conditions contributing to instability: Heat.

2. Incompatibility: Heat and oxidizing materials.

3. Hazardous decomposition products: Toxic gases and vapors (such as carbon monoxide).

III. Spill and Leak Procedures

A. Steps to be taken if the material is released or spilled. As much benzene as possible should be absorbed with suitable materials, such as dry sand or earth. That remaining must be flushed with large amounts of water. Do not flush benzene into a confined space, such as a sewer, because of explosion danger. Remove all ignition sources. Ventilate enclosed places.

B. Waste disposal method. Disposal methods must conform to other jurisdictional regulations. If allowed, benzene may be disposed of: (a) By absorbing it in dry sand or earth and disposing in a sanitary landfill; (b) if small quantities, by removing it to a safe location from buildings or other combustible sources, pouring it in dry sand or earth and cautiously igniting it; and (c) if large quantities, by atomizing it in a suitable combustion chamber.

IV. Miscellaneous Precautions

A. High exposure to benzene can occur when transferring the liquid from one container to another. Such operations should be well ventilated and good work practices must be established to avoid spills.

B. Use non-sparking tools to open benzene containers which are effectively grounded and bonded prior to opening and pouring.

C. Employers must advise employees of all plant areas and operations where exposure to benzene could occur. Common operations in which high exposures to benzene may be encountered are: the primary production and utilization of benzene, and transfer of benzene.

Appendix C—Medical Surveillance Guidelines for Benzene

I. Route of Entry

Inhalation; skin absorption.

II. Toxicology

Benzene is primarily an inhalation hazard. Systemic absorption may cause depression of the hematopoietic system, pancytopenia, aplastic anemia, and leukemia. Inhalation of high concentrations can affect central nervous system function. Aspiration of small amounts of liquid benzene immediately causes pulmonary edema and hemorrhage of pulmonary tissue. There is some absorption through the skin. Absorption may be more rapid in the case of abraded skin, and benzene may be more readily absorbed if it is present in a mixture or as a contaminant in solvents which are readily absorbed. The defatting action of benzene may produce primary irritation due to repeated or prolonged contact with the skin. High concentration are irritating to the eyes and the mucuous membranes of the nose, and respiratory tract.

III. Signs and Symptoms

Direct skin contact with benzene may cause erythema. Repeated or prolonged contact may result in drying, scaling dermatitis, or development of secondary skin infections. In addition, there is benzene absorption through the skin. Local effects of benzene vapor or liquid on the eye are slight. Only at very high concentrations is there any smarting sensation in the eye. Inhalation of high concentrations of benzene may have an initial stimulatory effect on the central nervous system characterized by exhilaration, nervous excitation, and/or giddiness, followed by a period of depression, drowsiness, or fatigue. A sensation of tightness in the chest accompanied by breathlessness may occur and ultimately the victim may lose consciousness. Tremors, convulsions and death may follow from respiratory paralysis or circulatory collapse in a few minutes to several hours following severe exposures.

The detrimental effect on the blood-forming system of prolonged exposure to small quantities of benzene vapor is of extreme importance. The hematopoietic system is the chief target for benzene's toxic effects which are manifested by alterations in the levels of formed elements in the peripheral blood. These effects have occurred at concentrations of benzene which may not cause irritation of mucous membranes, or any unpleasant sensory effects. Early signs and symptoms of benzene morbidity are varied, often not readily noticed and non-specific. Subjective complaints of headache, dizziness, and loss of appetite may precede or follow clinical signs. Rapid pulse and low blood pressure, in addition to a physical appearance of anemia, may accompany a subjective complaint of shortness of breath and excessive tiredness. Bleeding from the nose, gums, or mucous membranes, and the development of purpuric spots (small bruises) may occur as the condition progresses. Clinical evidence of leukopenia, anemia, and thrombocytopenia, singly or in combination, has been frequently reported among the first signs.

Bone marrow may appear normal, aplastic, or hyperplastic, and may not, in all situations, correlate with peripheral blood forming tissues. Because of variations in the susceptibility to benzene morbidity, there is no "typical" blood picture. The onset of effects of prolonged benzene exposure may be delayed for many months or years after the actual exposure has ceased and identification or correlation with benzene exposure must be sought out in the occupational history.

IV. Treatment of Acute Toxic Effects

Remove from exposure immediately. Make sure you are adequately protected and do not risk being overcome by fumes. Give oxygen or artificial resuscitation if indicated. Flush eyes, wash skin if contaminated and remove all contaminated clothing. Symptoms of intoxication may persist following severe exposures. Recovery from mild exposures is usually rapid and complete.

V. Surveillance and Preventive Considerations

A. General

The principal effects of benzene exposure which form the basis for this regulation are pathological changes in the hematopoietic system, reflected by changes in the peripheral blood and manifesting clinically as pancytopenia, aplastic anemia, and leukemia. Consequently, the medical surveillance program is designed to observe, on a regular basis, blood indices for early signs of these effects, and although early signs of leukemia are not usually available, emerging diagnostic technology and innovative regimes make consistent surveillance for leukemia, as well as other hematopoietic effects, essential.

Initial examinations are to be provided within 60 days of the effective date of this standard, or at the time of initial assignment, and periodic examinations annually thereafter. There are special provisions for medical tests in the event of hematologic abnormalities or for emergency situations.

The blood values which require referral to a hematologist or internist are noted in the standard in paragraph (i)(5). The standard specifies that blood abnormalities that persist must be referred "unless the physician has good reason to believe such referral is unnecessary" (paragraph (i)(5)). Examples of conditions that could make a referral unnecessary despite abnormal blood limits are iron or folate deficiency, menorrhagia, or blood loss due to some unrelated medical abnormality.

Symptoms and signs of benzene toxicity can be non-specific. Only a detailed history and appropriate investigative procedures will enable a physician to rule out or confirm conditions that place the employee at increased risk. To assist the examining physician with regard to which laboratory tests are necessary and when to refer an employee to the specialist, OSHA has established the following guidelines.

B. Hematology Guidelines

A minimum battery of tests is to be performed by strictly standardized methods.

1. Red cell, white cell, platelet counts, white blood cell differential, hematacrit and red cell indices must be performed by an accredited laboratory. The normal ranges for the red cell and white cell counts are influenced by altitude, race, and sex, and therefore should be determined by the accredited laboratory in the specific area where the tests are performed.

Either a decline from an absolute normal or an individual's base line to a subnormal value or a rise to a supra-normal value, are indicative of potential toxicity, particularly if all blood parameters decline. The normal total white blood count is approximately 7,200/mm ^{3} plus or minus 3,000. For cigarette smokers the white count may be higher and the upper range may be 2,000 cells higher than normal for the laboratory. In addition, infection, allergies and some drugs may raise the white cell count. The normal platelet count is approximately 250,000 with a range of 140,000 to 400,000. Counts outside this range should be regarded as possible evidence of benzene toxicity.

Certain abnormalities found through routine screening are of greater significance in the benzene-exposed worker and require prompt consultation with a specialist, namely:

a. Thrombocytopenia.

b. A trend of decreasing white cell, red cell, or platelet indices in an individual over time is more worrisome than an isolated abnormal finding at one test time. The importance of trend highlights the need to compare an individual's test results to baseline and/or previous periodic tests.

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c. A constellation or pattern of abnormalities in the different blood indices is of more significance than a single abnormality. A low white count not associated with any abnormalities in other cell indices may be a normal statistical variation, whereas if the low white count is accompanied by decreases in the platelet and/or red cell indices, such a pattern is more likely to be associated with benzene toxicity and merits thorough investigation.

Anemia, leukopenia, macrocytosis or an abnormal differential white blood cell count should alert the physician to further investigate and/or refer the patient if repeat tests confirm the abnormalities. If routine screening detects an abnormality, follow-up tests which may be helpful in establishing the etiology of the abnormality are the peripheral blood smear and the reticulocyte count.

The extreme range of normal for reticulocytes is 0.4 to 2.5 percent of the red cells, the usual range being 0.5 to 1.2 percent of the red cells, but the typical value is in the range of 0.8 to 1.0 percent. A decline in reticulocytes to levels of less than 0.4 percent is to be regarded as possible evidence (unless another specific cause is found) of benzene toxicity requiring accelerated surveillance. An increase in reticulocyte levels to about 2.5 percent may also be consistent with (but is not as characteristic of) benzene toxicity.

2. An important diagnostic test is a careful examination of the peripheral blood smear. As with reticulocyte count the smear should be with fresh uncoagulated blood obtained from a needle tip following venipuncture or from a drop of earlobe blood (capillary blood). If necessary, the smear may, under certain limited conditions, be made from a blood sample anticoagulated with EDTA (but never with oxalate or heparin). When the smear is to be prepared from a specimen of venous blood which has been collected by a commercial Vacutainer type tube containing neutral EDTA, the smear should be made as soon as possible after the venesection. A delay of up to 12 hours is permissible between the drawing of the blood specimen into EDTA and the preparation of the smear if the blood is stored at refrigerator (not freezing) temperature.

3. The minimum mandatory observations to be made from the smear are:

a. The differential white blood cell count.

b. Description of abnormalities in the appearance of red cells.

c. Description of any abnormalities in the platelets.

d. A careful search must be made throughout of every blood smear for immature white cells such as band forms (in more than normal proportion, i.e., over 10 percent of the total differential count), any number of metamyelocytes, myelocytes or myeloblasts. Any nucleate or multinucleated red blood cells should be reported. Large "giant" platelets or fragments of megakaryocytes must be recognized.

An increase in the proportion of band forms among the neutrophilic granulocytes is an abnormality deserving special mention, for it may represent a change which should be considered as an early warning of benzene toxicity in the absence of other causative factors (most commonly infection). Likewise, the appearance of metamyelocytes, in the absence of another probable cause, is to be considered a possible indication of benzene-induced toxicity.

An upward trend in the number of basophils, which normally do not exceed about 2.0 percent of the total white cells, is to be regarded as possible evidence of benzene toxicity. A rise in the eosinophil count is less specific but also may be suspicious of toxicity if the rises above 6.0 percent of the total white count.

The normal range of monocytes is from 2.0 to 8.0 percent of the total white count with an average of about 5.0 percent. About 20 percent of individuals reported to have mild but persisting abnormalities caused by exposure to benzene show a persistent monocytosis. The findings of a monocyte count which persists at more than 10 to 12 percent of the normal white cell count (when the total count is normal) or persistence of an absolute monocyte count in excess of $800/mm^3$ should be regarded as a possible sign of benzene-induced toxicity.

A less frequent but more serious indication of benzene toxicity is the finding in the peripheral blood of the so-called "pseudo" (or acquired) Pelger-Huet anomaly. In this anomaly many, or sometimes the majority, of the neutrophilic granulocytes possess two round nuclear segements—less often one or three round segments—rather than three normally elongated segments. When this anomaly is not hereditary, it is often but not invariably predictive of subsequent leukemia. However, only about two percent of patients who ultimately develop acute myelogenous leukemia show the acquired Pelger-Huet anomaly. Other tests that can be administered to investigate blood abnormalities are discussed below; however, such procedures should be undertaken by the hematologist.

An uncommon sign, which cannot be detected from the smear, but can be elicited by a "sucrose water test" of peripheral blood, is transient paroxysmal nocturnal hemoglobinuria (PNH), which may first occur insidiously during a period of established aplastic anemia, and may be followed within one to a few years by the appearance of rapidly fatal acute myelogenous leukemia. Clinical detection of PNH, which occurs in only one or two percent of those destined to have acute myelogenous leukemia, may be difficult; if the "sucrose water test" is positive, the somewhat more definitive Ham test, also known as the acid-serum hemolysis test, may provide confirmation.

e. Individuals documented to have developed acute myelogenous leukemia years after initial exposure to benzene may have progressed through a preliminary phase of hematologic abnormality. In some instances pancytopenia (i.e., a lowering in the counts of all circulating blood cells of bone marrow origin, but not to the extent implied by the term "aplastic anemia") preceded leukemia for many years. Depression of a single blood cell type or platelets may represent a harbinger of aplasia or leukemia. The finding of two or more cytopenias, or pancytopenia in a benzene-exposed individual, must be regarded as highly suspicious of more advanced although still reversible, toxicity. "Pancytopenia" coupled with the appearance of immature cells (myelocytes, myeloblasts, erythroblasts, etc.), with abnormal cells (pseudo Pelger-Huet anomaly, atypical nuclear heterochromatin, etc.), or unexplained elevations of white blood cells must be regarded as evidence of benzene overexposure unless proved otherwise. Many severely aplastic patients manifested the ominous finding of 5–10 percent myeloblasts in the marrow, occasional myeloblasts and myelocytes dihydrochloride, have revealed the disappearance of, or diminution in, peroxidase in a sizable proportion of the granulocytes, and this has been reported as an early sign of leukemia. However, relatively few patients have been studied to date. Granulocyte granules are normally strongly peroxidase positive. A steady decline in leukocyte alkaline phosphatase has also been reported as suggestive of early acute leukemia. Exposure to benzene may cause an early rise in serum iron, often but not always associated with a fall in the reticulocyte count. Thus, serial measurements of serum iron levels may provide a means of determining whether or not there is a trend representing sustained suppression of erythropoiesis.

Measurement of serum iron, determination of peroxidase and of alkaline phosphatase activity in peripheral granulocytes can be performed in most pathology laboratories. Peroxidase and alkaline phosphatase staining are usually undertaken when the index of suspecion for leukemia is high.

Appendix D—Sampling and Analytical Methods for Benzene Monitoring and Measurement Procedures

Measurements taken for the purpose of determining employee exposure to benzene are best taken so that the representative average 8-hour exposure may be determined from a single 8-hour sample or two (2) 4-hour samples. Short-time interval samples (or grab samples) may also be used to determine average exposure level if a minimum of five measurements are taken in a random manner over the 8-hour work shift. Random sampling means that any portion of the work shift has the same change of being sampled as any other. The arithmetic average of all such random samples taken on one work shift is an estimate of an employee's average level of exposure for that work shift. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). Sampling and analysis must be performed with procedures meeting the requirements of the standard.

There are a number of methods available for monitoring employee exposures to benzene. The sampling and analysis may be performed by collection of the benzene vaptor or charcoal absorption tubes, with subsequent chemical analysis by gas chromatography. Sampling and analysis may also be performed by portable direct reading instruments, real-time continuous monitoring systems, passive dosimeters or other suitable methods. The employer has the obligation of selecting a monitoring method which meets the accuracy and precision requirements of the standard under his unique field conditions. The standard requires that the method of monitoring must have an accuracy, to a 95 percent confidence level, of not less than plus or minus 25 percent for concentrations of benzene greater than or equal to 0.5 ppm.

The OSHA Laboratory modified NIOSH Method S311 and evaluated it at a benzene air concentration of 1 ppm. A procedure for determining the benzene concentration in bulk material samples was also evalauted. This work, reported in OSHA Laboratory Method No. 12, includes the following two analytical procedures:

I. OSHA Method 12 for Air Samples

Analyte: Benzene
Matrix: Air
Procedure: Adsorption on charcoal, desorption with carbon disulfide, analysis by GC.
Detection limit: 0.04 ppm
Recommended air volume and sampling rate: 10L to 0.2 L/min.

1. Principle of the Method.

1.1 A known volume of air is drawn through a charcoal tube to trap the organic vapors present.

1.2. The charcoal in the tube is transferred to a small, stoppered vial, and the anlyte is desorbed with carbon disulfide.

1.3. An aliquot of the desorbed sample is injected into a gas chromatograph.

1.4 The area of the resulting peak is determined and compared with areas obtained from standards.

2. Advantages and disadvantages of the method.

2.1 The sampling device is small, portable, and involved no liquids. Interferences are minimal, and most of those which do occur can be eliminated by altering chromatographic conditions. The samples are analyzed by means of a quick, instrumental method.

2.2 The amount of sample which can be taken is limited by the number of milligrams that the tube will hold before overloading. When the sample value obtained for the backup section of the charcoal tube exceeds 25 percent of that found on the front section, the possibility of sample loss exists.

3. Apparatus.

3.1 A calibrated personal sampling pump whose flow can be determined within ±5 percent at the recommended flow rate.

3.2. Charcoal tubes: Glass with both ends flame sealed, 7 cm long with a 6-mm O.D. and a 4-mm I.D., containing 2 sections of 20/40 mesh activated charcoal separated by a 2-mm portion of urethane foam. The activated charcoal is prepared from coconut shells and is fired at 600 °C prior to packing. The adsorbing section contains 100 mg of charcoal, the back-up section 50 mg. A 3-mm portion of urethane foam is placed between the outlet end of the tube and the back-up section. A plug of silanized glass wool is placed in front of the adsorbing section. The pressure drop across the tube must be less than one inch of mercury at a flow rate of 1 liter per minute.

3.3. Gas chromatograph equipped with a flame ionization detector.

3.4. Column (10-ft × ⅛-in stainless steel) packed with 80/100 Supelcoport coated with 20 percent SP 2100, 0.1 percent CW 1500.

3.5. An electronic integrator or some other suitable method for measuring peak area.

3.6. Two-milliliter sample vials with Teflon-lined caps.

3.7. Microliter syringes: 10-microliter (10-μL syringe, and other convenient sizes for making standards, 1-μL syringe for sample injections.

3.8. Pipets: 1.0 mL delivery pipets

3.9. Volumetric flasks: convenient sizes for making standard solutions.

4. Reagents.

4.1. Chromatographic quality carbon disulfide (CS_2). Most commercially available carbon disulfide contains a trace of benzene which must be removed. It can be removed with the following procedure:

Heat under reflux for 2 to 3 hours, 500 mL of carbon disulfide, 10 mL concentrated sulfuric acid, and 5 drops of concentrated nitric acid. The benzene is converted to nitrobenzene. The carbon disulfide layer is removed, dried with anhydrous sodium sulfate, and distilled. The recovered carbon disulfide should be benzene free. (It has recently been determined that benzene can also be removed by passing the carbon disulfide through 13x molecular sieve).

4.2. Benzene, reagent grade.

4.3. p-Cymene, reagent grade, (internal standard).

4.4. Desorbing reagent. The desorbing reagent is prepared by adding 0.05 mL of p-cymene per milliliter of carbon disulfide. (The internal standard offers a convenient means correcting analytical response for slight inconsistencies in the size of sample injections. If the external standard technique is preferred, the internal standard can be eliminated).

4.5. Purified GC grade helium, hydrogen and air.

5. Procedure.

5.1. Cleaning of equipment. All glassware used for the laboratory analysis should be properly cleaned and free of organics which could interfere in the analysis.

5.2. Calibration of personal pumps. Each pump must be calibrated with a representative charcoal tube in the line.

5.3. Collection and shipping of samples.

5.3.1. Immediately before sampling, break the ends of the tube to provide an opening at least one-half the internal diameter of the tube (2 mm).

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5.3.2. The smaller section of the charcoal is used as the backup and should be placed nearest the sampling pump.

5.3.3. The charcoal tube should be placed in a vertical position during sampling to minimize channeling through the charcoal.

5.3.4 Air being sampled should not be passed through any hose or tubing before entering the charcoal tube.

5.3.5. A sample size of 10 liters is recommended. Sample at a flow rate of approximately 0.2 liters per minute. The flow rate should be known with an accuracy of at least ±5 percent.

5.3.6. The charcoal tubes should be capped with the supplied plastic caps immediately after sampling.

5.3.7. Submit at least one blank tube (a charcoal tube subjected to the same handling procedures, without having any air drawn through it) with each set of samples.

5.3.8. Take necessary shipping and packing precautions to minimize breakage of samples.

5.4. Analysis of samples.

5.4.1. Preparation of samples. In preparation for analysis, each charcoal tube is scored with a file in front of the first section of charcoal and broken open. The glass wool is removed and discarded. The charcoal in the first (larger) section is transferred to a 2-ml vial. The separating section of foam is removed and discarded; the second section is transferred to another capped vial. These two sections are analyzed separately.

5.4.2. Desorption of samples. Prior to analysis, 1.0 mL of desorbing solution is pipetted into each sample container. The desorbing solution consists of 0.05 μL internal standard per mL of carbon disulfide. The sample vials are capped as soon as the solvent is added. Desorption should be done for 30 minutes with occasional shaking.

5.4.3. GC conditions. Typical operating conditions for the gas chromatograph are:

1.30 mL/min (60 psig) helium carrier gas flow.

2.30 mL/min (40 psig) hydrogen gas flow to detector.

3.240 mL/min (40 psig) air flow to detector.

4.150 °C injector temperature.

5.250 °C detector temperature.

6.100 °C column temperature.

5.4.4. Injection size. 1 μL.

5.4.5. Measurement of area. The peak areas are measured by an electronic integrator or some other suitable form of area measurement.

5.4.6. An internal standard procedure is used. The integrator is calibrated to report results in ppm for a 10 liter air sample after correction for desorption efficiency.

5.5. Determination of desorption efficiency.

5.5.1. Importance of determination. The desorption efficiency of a particular compound can vary from one laboratory to another and from one lot of chemical to another. Thus, it is necessary to determine, at least once, the percentage of the specific compound that is removed in the desorption process, provided the same batch of charcoal is used.

5.5.2. Procedure for determining desorption efficiency. The reference portion of the charcoal tube is removed. To the remaining portion, amounts representing 0.5X, 1X, and 2X and (X represents target concentration) based on a 10 L air sample are injected into several tubes at each level. Dilutions of benzene with carbon disulfide are made to allow injection of measurable quantities. These tubes are then allowed to equilibrate at least overnight. Following equilibration they are analyzed following the same procedure as the samples. Desorption efficiency is determined by dividing the amount of benzene found by amount spiked on the tube.

6. Calibration and standards. A series of standards varying in concentration over the range of interest is prepared and analyzed under the same GC conditions that will be used on the samples. A calibration curve is prepared by plotting concentration (μg/mL) versus peak area.

7. Calculations. Benzene air concentration can be calculated from the following equation:

$mg/m^3 = (A)(B)/(C)(D)$

Where: A = μg/mL benzene, obtained from the calibration curve

B = desorption volume (1 mL)

C = Liters of air sampled

D = desorption efficiency

The concentration in mg/m^3 can be converted to ppm (at 25° and 760 mm) with following equation:

$ppm = (mg/m^3)(24.46)/(78.11)$

Where: 24.46 = molar volume of an ideal gas 25 °C and 760 mm

78.11 = molecular weight of benzene

8. Backup Data.

8.1 Detection limit—Air Samples.

The detection limit for the analytical procedure is 1.28 ng with a coefficient of variation of 0.023 at this level. This would be equivalent to an air concentration of 0.04 ppm for a 10 L air sample. This amount provided a chromatographic peak that could be identifiable in the presence of possible interferences. The detection limit data were obtained by making 1 μL injections of a 1.283 μg/mL standard.

Injection	*Area Count*	
1	655.4	
2	617.5	
3	662.0	$\bar{X}$ = 640.2
4	641.1	SD = 14.9
5	636.4	CV = 0.023
6	629.2	

8.2. Pooled coefficient of variation—Air Samples. The pooled coefficient of variation for the analytical procedure was determined by 1 μL replicate injections of analytical standards. The standards were 16.04, 32.08, and 64.16 μg/mL, which are equivalent to 0.5, 1.0, and 2.0 ppm for a 10 L air sample respectively.

Injection	Area Counts		
	0.5 ppm	1.0 ppm	2.0 ppm
1	3996.5	8130.2	16481
2	4059.4	8235.6	16493
3	4052.0	8307.9	16535
4	4027.2	8263.2	16609
5	4046.8	8291.1	16552
6	4137.9	8288.8	16618
$\bar{X}$ =	4053.3	8254.0	16548.3
SD =	47.2	62.5	57.1
CV =	0.0116	0.0076	0.0034
$\bar{C}\bar{V}$ = 0.008			

8.3. Storage data—Air Samples

Samples were generated at 1.03 ppm benzene at 80% relative humidity, 22 °C, and 643 mm. All samples were taken for 50 minutes at 0.2 L/min. Six samples were analyzed immediately and the rest of the samples were divided into two groups by fifteen samples each. One group was stored at refrigerated temperature of −25 °C, and the other group was stored at ambient temperature (approximately 23 °C). These samples were analyzed over a period of fifteen days. The results are tabulated below.

PERCENT RECOVERY

Day analyzed	Refrigerated			Ambient		
0	97.4	98.7	98.9	97.4	98.7	98.9
0	97.1	100.6	100.9	97.1	100.6	100.9
2	95.8	96.4	95.4	95.4	96.6	96.9
5	93.9	93.7	92.4	92.4	94.3	94.1
9	93.6	95.5	94.6	95.2	95.6	96.6
13	94.3	95.3	93.7	91.0	95.0	94.6
15	96.8	95.8	94.2	92.9	96.3	95.9

8.4. Desorption data.

Samples were prepared by injecting liquid benzene onto the A section of charcoal tubes. Samples were prepared that would be equivalent to 0.5, 1.0, and 2.0 ppm for a 10 L air sample

PERCENT RECOVERY

Sample	0.5 ppm	1.0 ppm	2.0 ppm
1	99.4	98.8	99.5
2	99.5	98.7	99.7
3	99.2	98.6	99.8
4	99.4	99.1	100.0
5	99.2	99.0	99.7
6	99.8	99.1	99.9
$\bar{X}$ =	99.4	98.9	99.8
SD =	0.22	0.21	0.18
CV =	0.0022	0.0021	0.0018
$\bar{X}$ = 99.4			

8.5. Carbon disulfide

Carbon disulfide from a number of sources was analyzed for benzene contamination. The results are given in the following table. The benzene contamiant can be removed with the procedures given in section 4.1

Sample	µg Benzene/mL	ppm (equivalent for 10 L air sample)
Aldrich Lot 83017	4.20	0.13
Baker Lot 720364	1.01	0.03
Baker Lot 822351	1.01	0.03
Mallinkrodt Lot WEMP	1.74	0.05
Mallinkrodt Lot WDSJ	5.65	0.18
Mallinkrodt Lot WHGA	2.90	0.09
Treated CS_2		

II. OSHA Laboratory Method No. 12 for Bulk Samples

Analyte: Benzene.

Matrix: Bulk Samples.

Procedure: Bulk Samples are analyzed directly by high performance liquid chromatography (HPLC).

Detection limits: 0.01% by volume.

1. Principle of the method.

1.1. An aliquot of the bulk sample to be analyzed is injected into a liquid chromatograph.

1.2. The peak area for benzene is determined and compared to areas obtained from standards.

2. Advantages and disadvantages of the method.

2.1. The analytical procedure is quick, sensitive, and reproducible.

2.2. Reanalysis of samples is possible.

2.3. Interferences can be circumvented by proper selection of HPLC parameters.

2.4. Samples must be free of any particulates that may clog the capillary tubing in the liquid chromatograph. This may require distilling the sample or clarifying with a clarification kit.

3. Apparatus.

3.1. Liquid chromatograph equipped with a UV detector.

3.2. HPLC Column that will separate benzene from other components in the bulk sample being analyzed. The column used for validation studies was a Waters uBondapack C18, 30 cm x 3.9 mm.

3.3. A clarification kit to remove any particulates in the bulk if necessary.

3.4. A micro-distillation apparatus to distill any samples if necessary.

3.5. An electronic integrator or some other suitable method of measuring peak areas.

3.6. Microliter syringes—10 µL syringe and other convenient sizes for making standards. 10 µL syringe for sample injections.

3.7 Volumetric flasks, 5 mL and other convenient sizes for preparing standards and making dilutions.

4. Reagents.

4.1. Benzene, reagent grade.

4.2. HPLC grade water, methyl alcohol, and isopropyl alcohol.

5. Collection and shipment of samples.

5.1. Samples should be transported in glass containers with Teflon-lined caps.

5.2. Samples should not be put in the same container used for air samples.

6. Analysis of samples.

6.1. Sample preparation.

If necessary, the samples are distilled or clarified. Samples are analyzed undiluted. If the benzene concentration is out of the working range, suitable dilutions are made with isopropyl alcohol.

6.2. HPLC conditions.

The typical operating conditions for the high performance liquid chromatograph are:

1. Mobile phase—Methyl alcohol/water, 50/50

1. Analytical wavelength—254 nm

3 Injection size—10 µL

6.3. Measurement of peak area and calibration.

Peak areas are measured by an integrator or other suitable means. The integrator is calibrated to report results % in benzene by volume.

7. Calculations.

Since the integrator is programmed to report results in % benzene by volume in an undiluted sample, the following equation is used:

% Benzene by Volume = A x B

Where: A = % by volume on report

B = Dilution Factor

(B = 1 for undiluted sample)

8. Backup Data.

8.1. Detection limit—Bulk Samples.

The detection limit for the analytical procedure for bulk samples is 0.88 µg, with a coefficient of variation of 0.019 at this level. This amount provided a chromatographic peak that could be identifiable in the presence of possible interferences. The detection limit date were obtained by making 10 µL injections of a 0.10% by volume standard.

1	45386	
2	44214	
3	43822	$\bar{X}$ = 44040.1
4	44062	SD = 852.5
6	42724	CV = 0.019

8.2. Pooled coefficient of variation—Bulk Samples.

The pooled coefficient of variation for analytical procedure was determined by 50 μL replicate injections of analytical standards. The standards were 0.01, 0.02, 0.04, 0.10, 1.0, and 2.0% benzene by volume.

AREA COUNT (PERCENT)

Injection No.	0.01	0.02	0.04	0.10	1.0	2.0
1	45386	84737	166097	448497	4395380	9339150
2	44241	84300	170832	441299	4590800	9484900
3	43822	83835	164160	443719	4593200	9557580
4	44062	84381	164445	444842	4642350	9677060
5	44006	83012	168398	442564	4646430	9766240
6	42724	81957	173002	443975	4646260	.....
$\bar{X}$ =	44040.1	83703.6	167872	444149	4585767	9564986
SD =	852.5	1042.2	3589.8	2459.1	96839.3	166233
CV =	0.0194	0.0125	0.0213	0.0055	0.0211	0.0174
$\bar{CV}$ =	0.017					

Appendix E: Qualitative and Quantitative Fit Testing Procedures

I. Fit Test Protocols

A. The employer shall include the following provisions in the fit test procedures. These provisions apply to both qualitative fit testing (QLFT) and quantitative fit testing (QNFT).

1. The test subject shall be allowed to pick the most comfortable respirator from a selection including respirators of various sizes from different manufacturers. The selection shall include at least three sizes of elastomeric facepieces of the type of respirator that is to be tested, i.e., three sizes of half mask; or three sizes of full facepiece; and units from at least two manufacturers.

2. Prior to the selection process, the test subject shall be shown how to put on a respirator, how it should be positioned on the face, how to set strap tension and how to determine a comfortable fit. A mirror shall be available to assist the subject in evaluating the fit and positioning the respirator. This instruction may not constitute the subject's formal training on respirator use, at it is only a review.

3. The test subject shall be informed that he/she is being asked to select the respirator which provides the most comfortable fit. Each respirator represents a different size and shape, and if fitted and used properly, will provide adequate protection.

4. The test subject shall be instructed to hold each facepiece up to the face and eliminate those which obviously do not give a comfortable fit.

5. The more comfortable facepieces are noted; the most comfortable mask is donned and worn at least five minutes to assess comfort. Assistance in assessing comfort can be given by discussing the points in item 6 below. If the test subject is not familiar with using a particular respirator, the test subject shall be directed to don the mask several times and to ajust the straps each time to become adept at setting proper tension on the straps.

6. Assessment of comfort shall include reviewing the following points with the test subject and allowing the test subject adequate time to determine the comfort of the respirator:

(a) Position of the mask on the nose.

(b) Room for eye protection.

(c) Room to talk.

(d) Position of mask on face and cheeks.

7. The following criteria shall be used to help determine the adequacy of the respirator fit:

(a) Chin properly placed:

(b) Adequate strap tension, not overly tightened:

(c) Fit across nose bridge:

(d) Respirator of proper size to span distance from nose to chin;

(e) Tendency of respirator to slip;

(f) Self-observation in mirror to evaluate fit and respirator position.

8. The test subject shall conduct the negative and positive pressure fit checks as described below or ANSI Z88.2–1980. Before conducting the negative or positive pressure test, the subject shall be told to seat the mask on the face by moving the head from side-to-side and up and down slowly while taking in a few slow deep breaths. Another facepiece shall be selected and retested if the test subject fails the fit check tests.

(a) *Positive pressure test.* Close off the exhalation value and exhale gently onto the facepiece. The face fit is considered satisfactory if a slight positive pressure can be built up inside the facepiece without any evidence of outward leakage of air at the seal. For most respirators this method of leak testing requires the wearer to first remove the exhalation value cover before closing off the exhalation value and then carefully replacing it after the test.

(b) *Negative pressure test.* Close off the inlet opening of the canister or cartridge(s) by covering with the palm of the hand(s) or by replacing the filter seal(s), inhale gently so that the facepiece collapses slightly, and hold the breath for ten seconds. If the facepiece remains in its slightly collapsed condition and no inward leakage of air is detected, the tightness of the respirator is considered satisfactory.

9. The test shall not be conducted if there is any hair growth between the skin and the facepiece sealing surface, such as stubble beard growth, beard, or long sideburns which cross the respirator sealing surface. Any type of apparel which interferes with a satisfactory fit shall be altered or removed.

10. If a test subject exhibits difficulty in breathing during the tests, she or he shall be referred to a physician trained in respiratory disease or pulmonary medicine to determine whether the test subject can wear a respirator while performing her or his duties.

11. The test subject shall be given the opportunity to wear the successfully fitted respirator for a period of two weeks. If at any time during this period the respirator becomes uncomfortable, the test subject shall be given the opportunity to select a different facepiece and to be retested.

12. The employer shall certify that a successful fit test has been administered to the employee. The certification shall include the following information:

(a) Name of employee:

(b) Type, brand and size of respirator; and

(c) Date of test.

Where QNFT is used, the fit factor, strip chart, or other recording of the results of the test, shall be retained with the certification. The certification shall be maintained until the next fit test is administered.

13. Exercise regimen. Prior to the commencement of the fit test, the test subject shall be given a description of the fit test and the test subject's responsibilities during the test procedure. The description of the process shall include a description of the test exercises that the subject will be performing. The respirator to be tested shall be worn for at least 5 minutes before the start of the fit test.

14. Test Exercises. The test subject shall perform exercises, in the test environment, in the manner described below:

(a) Normal breathing. In a normal standing position, without talking, the subject shall breathe normally.

(b) Deep breathing. In a normal standing position, the subject shall breathe slowly and deeply, taking caution so as to not hyperventilate.

(c) Turning head side to side. Standing in place, the subject shall slowly turn his/her head from side to side between the extreme positions on each side. The head shall be held at each extreme momentarily so the subject can inhale at each side.

(d) Moving head up and down. Standing in place, the subject shall slowly move his/her head up and down. The subject shall be instructed to inhale in the up position (i.e., when looking toward the ceiling).

(e) Talking. The subject shall talk out loud slowly and loud enough so as to be heard clearly by the test conductor. The subject can read from a prepared text such as the Rainbow Passage, count backward from 100, or recite a memorized poem or song.

(f) Grimace. The test subject shall grimace by smiling or frowning.

(g) Bending over. The test subject shall bend at the waist as if he/she were to touch his/her toes. Jogging in place shall be substituted for this exercise in those test environments such as shroud type QNFT units which prohibit bending at the waist.

(h) Normal breathing. Same as exercise 1.

Each test exercise shall be performed for one minute except for the grimace exercise which shall be performed for 15 seconds.

The test subject shall be questioned by the test conductor regarding the comfort of the respirator upon completion of the protocol. If it has become uncomfortable, another model of respirator shall be tried.

B. Qualitative Fit Test (QLFT) Protocols.

1. General.

(a) The employer shall assign specific individuals who shall assume full responsibility for implementing the respirator qualitative fit test program.

(b) The employer shall ensure that persons administering QLFT are able to prepare test solutions, calibrate equipment and perform tests properly, recognize invalid tests, and assure that test equipment is in proper working order.

(c) The employer shall assure that QLFT equipment is kept clean and well maintained so as to operate at the parameters for which it was designed.

2. *Isoamyl Acetate Protocol.*

(a) Odor threshold screening.

The odor threshold screening test, performed without wearing a respirator, is intended to determine if the individual tested can detect the odor of isoamyl acetate.

(1) Three 1-liter glass jars with metal lids are required.

(2) Odor free water (e.g. distilled or spring water) at approximately 25 degrees C shall be used for the solutions.

(3) The isoamyl acetate (IAA) (also known as isopentyl acetate) stock solution is prepared by adding 1 cc of pure IAA to 800 cc of odor free water in a 1 liter jar and shaking for 30 seconds. A new solution shall be prepared at least weekly.

(4) The screening test shall be conducted in a room separate from the room used for actual fit testing. The two rooms shall be well ventilated but shall not be connected to the same recirculating ventilation system.

(5) The odor test solution is prepared in a second jar by placing 0.4 cc of the stock solution into 500 cc of odor free water using a clean dropper or pipette. The solution shall be shaken for 30 seconds and allowed to stand for two to three minutes so that the IAA concentration above the liquid may reach equilibrium. This solution shall be used for only one day.

(6) A test blank shall be prepared in a third jar by adding 500 cc of odor free water.

(7) The odor test and test blank jars shall be labeled 1 and 2 for jar identification. Labels shall be placed on the lids so they can be periodically peeled, dried off and switched to maintain the integrity of the test.

(8) The following instruction shall be typed on a card and placed on the table in front of the two test jars (i.e., 1 and 2): "The purpose of this test is to determine if you can smell banana oil at a low concentration. The two bottles in front of you contain water. One of these bottles also contains a small amount of banana oil. Be sure the covers are on tight, then shake each bottle for two seconds. Unscrew the lid of each bottle, one at a time, and sniff at the mouth of the bottle. Indicate to the test conductor which bottle contains banana oil."

(9) The mixtures used in the IAA odor detection test shall be prepared in an area separate from where the test is performed, in order to prevent olfactory fatigue in the subject.

(10) If the test subject is unable to correctly identify the jar containing the odor test solution, the IAA qualitative fit test shall not be performed.

(11) If the test subject correctly identifies the jar containing the odor test solution, the test subject may proceed to respirator selection and fit testing.

(b) Isoamyl acetate fit test.

(1) The fit test chamber shall be similar to a clear 55-gallon drum liner suspended inverted over a 2-foot diameter frame so that the top of the chamber is about 6 inches above the test subject's head. The inside top center of the chamber shall have a small hook attached.

(2) Each respirator used for the fitting and fit testing shall be equipped with organic vapor cartridges or offer protection against organic vapors. The cartridges or masks shall be changed at least weekly.

(3) After selecting, donning, and properly adjusting a respirator, the test subject shall wear it to the fit testing room. This room shall be separate from the room used for odor threshold screening and respirator selection, and shall be well ventilated, as by an exhaust fan or lab hood, to prevent general room contamination.

(4) A copy of the test exercises and any prepared text from which the subject is to read shall be taped to the inside of the test chamber.

(5) Upon entering the test chamber, the test subject shall be given a 6-inch by 5-inch piece of paper towel, or other porous, absorbent, single-ply material, folded in half and wetted with 0.75 cc of pure IAA. The test subject shall hand the wet towel on the hook at the top of the chamber.

(6) Allow two minutes for the IAA test concentration to stabilize before starting the fit test exercises. This would be an appropriate time to talk with the test subject; to explain the fit test, the importance of his/her cooperation, and the purpose for the head exercises; or to demonstrate some of the exercises.

(7) If at any time during the test, the subject detects the banana like odor of IAA, the test has failed. The subject shall quickly exit from the test chamber and leave the test area to avoid olfactory fatigue.

(8) If the test has failed, the subject shall return to the selection room and remove the respirator, repeat the odor sensitivity test, select and put on another respirator, return to the test chamber and again begin the procedure described in (1) through (7) above. The process continues until a respirator that fits well has been found. Should the odor sensitivity test be failed, the subject shall wait about 5 minutes before retesting. Odor sensitivity will usually have returned by this time.

(9) When a respirator is found that passes the test, its efficiency shall be demonstrated for the subject by having the subject break the face seal and take a breath before existing the chamber.

(10) When the test subject leaves the chamber, the subject shall remove the saturated towel and return it to the person conducting the test. To keep the test area from becoming contaminated, the used towels shall be kept in a self sealing bag so there is no significant IAA concentration build-up in the test chamber during subsequent tests.

3. *Saccharin Solution Aerosol Protocol.*

The saccharin solution aerosol QLFT protocol is the only currently available, validated test protocol for use with particulate disposable dust respirators not equipped with high-efficiency filters. The entire screening and testing procedure shall be explained to the test subject prior to the conduct of the screening test.

(a) Taste threshold screening.

The saccharin taste threshold screening, performed without wearing a respirator, is intended to determine whether the individual being tested can detect the taste of saccharin.

(1) Threshold screening as well as fit testing subjects shall wear an enclosure about the head and shoulders that is approximately 12 inches in diameter by 14 inches tall with at least the front portion clear and that allows free movements of the head when a respirator is worn. An enclosure substantially similar to the 3M hood assembly, parts # FT 14 and # FT 15 combined, is adequate.

(2) The test enclosure shall have a ¾-inch hole in front of the test subject's nose and mouth area to accommodate the nebulizer nozzle.

(3) The test subject shall don the test enclosure. Throughout the threshold screening test, the test subject shall breathe through his/her wide open mouth with tongue extended.

(4) Using a DeVilbiss Model 40 Inhalation Medication Nebulizer the test conductor shall spray the *threshold check solution* into the enclosure. This nebulizer shall be clearly marked to distinguish it from the fit test solution nebulizer.

(5) The *threshold check solution* consists of 0.83 grams of sodium saccharin USP in 1 cc of warm water. It can be prepared by putting 1 cc of the fit test solution (see (b)(5) below) in 100 cc of distilled water.

(6) To produce the aerosol, the nebulizer bulb is firmly squeezed so that it collapses completely, then released and allowed to fully expand.

(7) Ten squeezes are repeated rapidly and then the test subject is asked whether the saccharin can be tasted.

(8) If the first response is negative, ten more squeezes are repeated rapidly and the test subject is again asked whether the saccharin is tasted.

(9) If the second response is negative, ten more squeezes are repeated rapidly and the test subject is again asked whether the saccharin is tasted.

(10) The test conductor will take note of the number of squeezes required to solicit a taste response.

(11) If the saccharin is not tasted after 30 squeezes (step 10), the test subject may not perform the saccharin fit test.

(12) If a taste response is elicited, the test subject shall be asked to take note of the taste for reference in the fit test.

(13) Correct use of the nebulizer means that approximately 1 cc of liquid is used at a time in the nebulizer body.

(14) The nebulizer shall be thoroughly rinsed in water, shaken dry, and refilled at least each morning and afternoon or at least every four hours.

(b) Saccharin solution aerosol fit test procedure.

(1) The test subject may not eat, drink (except plain water), or chew gum for 15 minutes before the test.

(2) The fit test uses the same enclosure described in (a) above.

(3) The test subject shall don the enclosure while wearing the respirator selected in section (a) above. The respirator shall be properly adjusted and equipped with a particulate filter(s).

(4) A second DeVilbiss Model 40 Inhalation Medication Nebulizer is used to spray the fit test solution into the enclosure. This nebulizer shall be clearly marked to distinguish it from the screening test solution nebulizer.

(5) The fit test solution is prepared by adding 83 grams of sodium saccharin to 100 cc of warm water.

(6) As before, the test subject shall breathe through the open mouth with tongue extended.

(7) The nebulizer is inserted into the hole in the front of the enclosure and the fit test solution is sprayed into the enclosure using the same number of squeezes required to elicit a taste response in the screening test.

(8) After generating the aerosol the test subject shall be instructed to perform the exercises in section I. A. 14 above.

(9) Every 30 seconds the aerosol concentration shall be replenished using one half the number of squeezes as initially.

(10) The test subject shall indicate to the test conductor if at any time during the fit test the taste of saccharin is detected.

(11) If the taste of saccharin is detected, the fit is deemed unsatisfactory and a different respirator shall be tried.

4. *Irritant Fume Protocol.*

(a) The respirator to be tested shall be equipped with high-efficiency particulate air (HEPA) filters.

(b) The test subject shall be allowed to smell a weak concentration of the irritant smoke before the respirator is donned to become familiar with its characteristic odor.

(c) Break both ends of a ventilation smoke tube containing stannic oxychloride, such as the MSA part No. 5645, or equivalent. Attach one end of the smoke tube to a low flow air pump set to deliver 200 milliliters per minute.

(d) Advise the test subject that the smoke can be irritating to the eyes and instruct the subject to keep his/her eyes closed while the test is performed.

(e) The test conductor shall direct the stream of irritant smoke from the smoke tube towards the face seal area of the test subject. He/She shall begin at least 12 inches from the facepiece and gradually move to within one inch, moving around the whole perimeter of the mask.

(f) The exercises identified in section I. A. 14 above shall be performed by the test subject while the respirator seal is being challenged by the smoke.

(g) Each test subject passing the smoke test without evidence of a response shall be given a sensitivity check of the smoke from the same tube once the respirator has been removed to determine whether he/she reacts to the smoke. Failure to evoke a response shall void the fit test.

(h) The fit test shall be performed in a location with exhaust ventilation sufficient to prevent general contamination of the testing area by the test agent.

C. Quantiative Fit Test (QNFT) Protocol.

1. General.

(a) The employer shall assign specific individuals who shall assume full responsibility for implementing the respirator quantitative fit test program.

(b) The employer shall ensure that persons administering QNFT are able to calibrate equipment and perform tests properly, recognize invalid tests, calculate fit factors properly and assure that test equipment is in proper working order.

(c) The employer shall assure that QNFT equipment is kept clean and well maintained so as to operate at the parameters for which it was designed.

2. Definitions.

(a) Quantitative fit test. The test is performed in a test chamber. The normal air-purifying element of the respirator is replaced by a high-efficiency particulate air (HEPA) filter in the case of particulate QNFT aerosols or a sorbent offering contaminant penetration protection equivalent to high-efficiency filters where the QNFT test agent is a gas or vapor.

(b) Challenge agent means the aerosol, gas or vapor introduced into a test chamber so that its concentration inside and outside the respirator may be measured.

(c) Test subject means the person wearing the respirator for quantitative fit testing.

(d) Normal standing position means standing erect and straight with arms down along the sides and looking straight ahead.

(e) Maximum peak penetration method means the method of determining test agent penetration in the respirator as determined by strip chart recordings of the test. The highest peak penetration for a given exercise is taken to be representative of average penetration into the respirator for that exercise.

(f) Average peak penetration method means the method of determining test agent penetration into the respirator utilizing a strip chart recorder, integrator, or computer. The agent penetration is determined by an average of the peak heights on the graph or by computer integration, for each exercise except the grimace exercise. Integrators or computers which calculate the actual test agent penetration into the respirator for each exercise will also be considered to meet the requirements of the average peak penetration method.

(g) "Fit Factor" means the ration of challenge agent concentration outside with respect to the inside of a respirator inlet covering (facepiece or enclosure).

3. Apparatus.

(a) Instrumentation. Aerosol generation, dilution, and measurement systems using corn oil or sodium chloride as test aerosols shall be used for quantitatives fit testing.

(b) Test chamber. The test chamber shall be large enough to permit all test subjects to perform freely all required exercises without distrubing the challenge agent concentration or the measurement apparatus. The test chamber shall be equipped and constructed so that the challenge agent is effectively isolated from the ambient air, yet uniform in concentration throughout the chamber.

(c) When testing air-purifying respirators, the normal filter or cartridge element shall be replaced with a high-efficiency particulate filter supplied by the same manufacturer.

(d) The sampling instrument shall be selected so that a strip chart record may be made of the test showing the rise and fall of the challenge agent concentration with each inspiration and expiration at fit factors of at least 2,000. Integrators or computers which integrate the amount of test agent penetration leakage into the respirator for each exercise may be used provided a record of the readings is made.

(e) The combination of substitute air-purifying elements, challenge agent and challenge agent concentration in the test chamber shall be such that the test subject is not exposed in excess of an established exposure limit for the challenge agent at any time during the testing process.

(f) The sampling port on the test specimen respirator shall be placed and constructed so that no leakage occurs around the port (e.g. where the respirator is probed), a free air flow is allowed into the sampling line at all times and so that there is no interference with the fit or performance of the respirator.

(g) The test chamber and test set up shall permit the person administering the test to observe the test subject inside the chamber during the test.

(h) The equipment generating the challenge atmosphere shall maintain the concentration of challenge agent inside the test chamber constant to within a 10 percent variation for the duration of the test.

(i) The time lag (interval between an event and the recording of the event on the strip chart or computer or integrator) shall be kept to a minimum. There shall be a clear association between the occurrence of an event inside the test chamber and its being recorded.

(j) The sampling line tubing for the test chamber atmosphere and for the respirator sampling port shall be of equal diameter and of the same material. The length of the two lines shall be equal.

(k) The exhaust flow from the test chamber shall pass through a high-efficiency filter before release.

(l) When sodium chloride aerosol is used, the relative humidity inside the test chamber shall not exceed 50 percent.

(m) The limitations of instrument detection shall be taken into account when determining the fit factor.

(n) Test respirators shall be maintained in proper working order and inspected for deficiencies such as cracks, missing valves and gaskets, etc.

4. Procedural Requirements.

(a) When performing the initial positive or negative pressure test the sampling line shall be crimped closed in order to avoid air pressure leakage during either of these tests.

(b) An abbreviated screening isoamyl acetate test or irritant fume test may be utilized in order to quickly identify poor fitting respirators which passed the positive and/or negative pressure test and thus reduce the amount of QNFT time. When performing a screening isoamyl acetate test, combination high-efficiency organic vapor cartridges/canisters shall be used.

(c) A reasonably stable challenge agent concentration shall be measured in the test chamber prior to testing. For canopy or shower curtain type of test units the determination of the challenge agent stability may be established after the test subject has entered the test environment.

(d) Immediately after the subject enters the test chamber, the challenge agent concentration inside the respirator shall be measured to ensure that the peak penetration does not exceed 5 percent for a half mask or 1 percent for a full facepiece respirator.

(e) A stable challenge concentration shall be obtained prior to the actual start of testing.

(f) Respirator restraining straps shall not be overtightened for testing. The straps shall be adjusted by the wearer without assistance from other persons to give a reasonable comfortable fit typical of normal use.

(g) The test shall be terminated whenever any single peak penetration exceeds 5 percent for half masks and 1 percent for full facepiece respirators. The test subject shall be refitted and retested. If two of the three required tests are terminated, the fit shall be deemed inadequate.

(h) In order to successfully complete a QNFT, three successful fit tests are required. The results of each of the three independent fit tests must exceed the minimum fit factor needed for the class of respirator (e.g. half mask respirator, full facepiece respirator).

(i) Calculation of fit factors.

(1) The fit factor shall be determined for the quantitative fit test by taking the ratio of the average chamber concentration to the concentration inside the respirator.

(2) The average test chamber concentration is the arithmetic average of the test chamber concentration at the beginning and of the end of the test.

(3) The concentration of the challenge agent inside the respirator shall be determined by one of the following methods:

(i) Average peak concentration.

(ii) Maximum peak concentration.

(iii) Integration by calculation of the area under the individual peak for each exercise. This includes computerized integration.

(j) Interpretation of test results. The fit factor established by the quantitative fit testing shall be the lowest of the three fit factor values calculated from the three required fit tests.

(k) The test subject shall not be permitted to wear a half mask, or full facepiece respirator unless a minimum fit factor equivalent to at least 10 times the hazardous exposure level is obtained.

(l) Filters used for quantitative fit testing shall be replaced at least weekly, or whenever increased breathing resistance is encountered, or when the test agent has altered the integrity of the filter media. Organic vapor cartridges/canisters shall be replaced daily (when used) or sooner if there is any indication of breakthrough by a test agent.

TABLE I
RESPIRATORY PROTECTION FOR COKE OVEN EMISSIONS

Airborne concentration of coke oven emissions	*Required respirator*
(a) Any concentration.	**(1)** A Type C supplied air respirator operated in pressure demand or other positive pressure or continuous flow mode; or
	(2) A powered air-purifying particulate filter respirator for dust, and mist;
	(3) A powered air-purifying particulate filter respirator or combination chemical cartridge and particulate filter respirator for coke oven emissions.
(b) Concentrations not greater than 1500 /m^3.	**(1)** Any particulate filter respirator for dust and mist, excepts single-use respirator; or
	(2) Any particulate filter respirator or combination chemical cartridge and particulate filter respirator for coke oven emissions; or
	(3) Any respirator listed in paragraph (g)(2)(i)(a) of this section.

APPENDIX A — COKE OVEN EMISSIONS SUBSTANCE INFORMATION SHEET

I. SUBSTANCE IDENTIFICATION

A. *Substance:* Coke Oven Emissions

B. *Definition:* The Benzene-soluble fraction of total particulate matter present during the destructive distillation or carbonization of coal for the production of coke.

C. *Permissible Exposure Limit:* 150 micrograms per cubic meter of air determined as an average over 8-hour period.

D. *Regulated areas:* Only employees authorized by your employer should enter a regulated area. The employer is required to designate the following areas as regulated areas: the coke oven battery, including topside and its machinery, pushside and its machinery, cokeside and its machinery, and the battery ends: the screening station; the wharf; and the beehive ovens and their machinery.

II. HEALTH HAZARD DATA

Exposure to coke oven emissions is a cause of lung cancer, and kidney cancer, in humans. Although there have not been an excess number of skin cancer cases in humans, repeated skin contact with coke oven emissions should be avoided.

III. PROTECTIVE CLOTHING AND EQUIPMENT

A. *Respirators:* Respirators will be provided by your employer for routine use if your employer is in the process of implementing engineering and work practice controls or where engineering and work practice controls are not feasible or insufficient to reduce exposure to or below the PEL. You must wear respirators for non-routine activities or in emergency situations where you are likely to be exposed to levels of coke oven emissions in excess of the permissible exposure limit. Until January 20, 1978, the routine wearing of respirators is voluntary. Until that date, if you choose not to wear a respirator you do not have to do so. You must still have your respirator with you and you must still wear it if you are near visible emissions. Since how well your respirator fits your face is very important, your employer is required to conduct fit tests to make sure the respirator seals properly when you wear it. These tests are simple and rapid and will be explained to you during your training sessions.

B. *Protective clothing:* Your employer is required to provide, and you must wear, appropriate, clean, protective clothing and equipment to protect your body from repeated skin contact with coke oven emissions and from the heat generated during the coking process. This clothing should include such items as jacket and pants and flame resistant gloves. protective equipment should include face shield or vented goggles, protective helmets and safety shoes, insulated from hot surfaces where appropriate.

IV. HYGIENE FACILITIES AND PRACTICES

You must not eat, drink, smoke, chew gum or tobacco, or apply cosmetics in the regulated area, except that drinking water is permitted. Your employer is required to provide lunchrooms and other areas for these purposes.

Your employer is required to provide showers, washing facilities, and change rooms. If you work in a regulated area, you must wash your face, and hands before eating. You must shower at the end of the work shift. Do not take used protective clothing out of the change rooms without your employer's permission. Your employer is required to provide for laundering or cleaning of your protective clothing.

V. SIGNS AND LABELS

Your employer is required to post warning signs and labels for your protection. Signs must be posted in regulated areas. The signs must warn that a cancer hazard is present, that only authorized employees may enter the area, and that no smoking or eating is allowed. In regulated areas where coke oven emissions are above the permissible exposure limit, the signs should also warn that respirators must be worn.

VI. MEDICAL EXAMINATIONS

If you work in a regulated area at least 30 days per year, your employer is required to provide you with a medical examination every year. The medical examination must include a medical history, a chest x-ray; pulmonary function test; weight comparison; skin examination; a urinalysis and a urine and sputum cytology exam for the early detection of urinary or lung cancer. The cytology exams are only included in the initial exam until you are either 45 years or older or have 5 or more years employment in the regulated areas when the medical exams including these tests are to be given every 6 months. The examining physician will provide a written opinion to your employer containing the results of the medical exam. You should also receive a copy of this opinion.

VII. OBSERVATION OF MONITORING

Your employer is required to monitor your exposure to coke oven emissions and you are entitled to observe the monitoring procedure. You are entitled to receive an explanation of the measurement procedure, observe the steps taken in the measurement procedure, and to record the results obtained. When the monitoring procedure is taking place in an area where respirators or personal protective clothing and equipment are required to be worn, you must also be provided with and must wear the protective clothing and equipment.

VIII. ACCESS TO RECORDS

You or your representative are entitled to records of your exposure to coke oven emissions upon request to your employer. Your medical examination records can be furnished to your physician upon request to your employer.

IX. TRAINING AND EDUCATION

Additional information on all of these items plus training as to hazards of coke oven emissions and the engineering and work practice controls associated with your job will also be provided by your employer.

APPENDIX B — INDUSTRIAL HYGIENE AND MEDICAL SURVEILLANCE GUIDELINES

I. INDUSTRIAL HYGIENE GUIDELINES

A. *Sampling.* (Benzene-Soluble Fraction Total Particulate Matter).

Samples collected should be full shift (at least 7-hour) samples. Sampling should be done using a personal sampling pump with pulsation damper at a flow rate of 2 liters per minute. Samples should be collected on 0.8 micrometer pore size silver membrane filters (37 mm diameter) preceded by Gelman glass fiber type A-E filters encased in three-piece plastic (polystyrene) field monitor cassettes. The cassette face cap should be on and the plug removed. The rotameter should be checked every hour to ensure that proper flow rates are maintained.

A miminum of three full-shift samples should be collected for each job classification on each battery, at least one from each shift. If disparate results are obtained for particular job classification, sampling should be repeated. It is advisable to sample each shift on more than one day to account for environmental variables (wind, precipitation, etc.) which may affect sample. Differences in exposures among different work shifts may indicate a need to improve work practices on a particular shift. Sampling results from different shifts for each job classification should not be averaged. Multiple samples from the same shift on each battery may be used to calculate an average exposure for a particular job classification.

B. *Analysis.*

1. All extraction glassware is cleaned with dichromic acid cleaning solution, rinsed with tap water, then dionized water, acetone, and allowed to dry completely. The glassware is rinsed with nanograde benzene before use. The Teflon cups are cleaned with benzene then with acetone.

2. Pre-weigh the 2 ml Teflon cups to one hundredth of a milligram (0.01 mg) on a autobalance AD 2 Tare weight of the cups is about 50 mg.

3. Place the silver membrane filter and glass fiber filter into a 15 ml test tube.

4. Extract with 5 ml of benzene for five minutes in an ultrasonic cleaner.

5. Filter the extract in 15 ml medium glass fritted funnels.

6. Rinse test tube and filters with two 1.5 ml aliquots of benzene and filter through the fritted glass funnel.

7. Collect the extract and two rinses in a 10 ml Kontes graduated evaporative concentrator.

8. Evaporate down to 1 ml while rinsing the sides with benzene.

9. Pipet 0.5 ml into the Teflon cup and evaporate to dryness in a vacuum oven at 40° C for 3 hours.

10. Weigh the Teflon cup and the weight gain is due to the benzene soluble residue in half the Sample.

II. MEDICAL SURVEILLANCE GUIDELINES

A. *General.*

The minimum requirements for the medical examination for coke oven workers are given in paragraph (j) of the standard.

The initial examination is to be provided to all coke oven workers who work at least 30 days in the regulated area.

The examination includes at 14'' × 17'' posterior-anterior chest x-ray and a ILO/UC rating to assure some standardization of x-ray reading, pulmonary function tests (FVC and FEV 1.0), weight, urinalysis, skin examination and a sputum and urinary cytologic examination. These tests are to serve as the baseline for comparing the employee's future test results. Periodic exams include all the elements of the initial exams except that the cytologic tests need be performed only on those employees who are 45 years of age or older or who have worked for 5 or more years in the related area; periodic exams are to be performed semiannually for this group instead of annually. The examination contents are minimum requirements, additional tests such as lateral and oblique x-rays or additinal pulmonary function tests may be performed if deemed necessary.

B. *Pulmonary function tests.*

Pulmonary function tests should be performed in a manner which minimizes subject and operator bias. There has been shown to be learning effects with regard to the results obtained from certain tests, such as FEV 1.0. Best results can be obtained by multiple trials for each subject. The best of three trials or the average of the last three of five trials may be used in obtaining reliable results. The type of equipment used (manufacturer, model, etc.) should be recorded with the results as reliability and accuracy varies and such information may be important in the evaluation of test results. Care should be exercised to obtain the best possible testing equipment.

C. *Sputum cytology.*

Sputum can be collected by aerosol inhalation during the medical exam or by spontaneous early morning cough at home. Sputum is induced by transoral inhalation of an aerosolized solution of eight per cent (8%) sodium chloride in water. After inhaling as few as three to five breaths the subject usually yields an adequate sputum specimen. A minimum of three samples should be collected by the subject at home. All sputum should be collected directly into sixty per cent (60%) alcohol.

Scientific evidence suggests that chest x-rays and sputum cytology should be used together as screening tests for lung cancer in high risk populations, such as coke oven workers. The tests are to be performed every six months on workers who are 45 years of age or older or have worked in the regulated area for 5 or more years. Since the tests seem to be complementary, it may be advantageous to alternate the test procedures. For instance, chest x-rays could be obtained in June and December and sputum cytologys should be obtained in March and September. Facilities for providing necessary diagnostic investigation should be readily available as well as chest physicians, surgeons, radiologists, pathologists, and immunotherapists to provide any necessary treatment services.

APPENDIX A – AIR SAMPLING AND ANALYTICAL PROCEDURES FOR DETERMINING CONCENTRATIONS OF COTTON DUST

I. SAMPLING LOCATIONS

The sampling procedures must be designed so that samples of the actual dust concentrations are collected accurately and consistently and reflect the concentrations of dust at the place and time of sampling. Sufficient number of 6-hour area samples in each distinct work area of the plant should be collected at locations which provide representative samples of air to which the worker is exposed. In order to avoid filter overloading, sampling time may be shortened when sampling in dusty areas. Samples in each work area should be gathered simultaneously or sequentially during a normal operating period. The daily time-weighted average (TWA) exposure of each worker can then be determined by using the following formula:

$$\frac{\text{Summation of hours spent in each location and the dust concentration in that location.}}{\text{Total hours exposed}}$$

A time-weighted average concentration should be computed for each worker and properly logged and maintained on file for review.

II. SAMPLING EQUIPMENT

A. **Sampler.**

The instrument selected for monitoring is the Lumsden-Lynch vertical elutriator. It should operate at a flow rate of 7.4±0.2 liters/minute.

The samplers should be cleaned prior to sampling. The pumps should be monitored during sampling.

B. **Filter Holder.**

A three-piece cassette constructed of polystyrene designed to hold a 37-mm diameter filter should be used. Care must be exercised to insure that an adequate seal exists between elements of the cassette.

C. **Filters and Support Pads.**

The membrane filters used should be polyvinyl chloride with a 5-mm pore size and 37-mm diameter. A support pad, commonly called a backup pad, should be used under the filter membrane in the field monitor cassette.

D. **Balance.**

A balance sensitive to 10 micrograms should be used.

III. INSTRUMENT CALIBRATION PROCEDURE

Samplers shall be calibrated when first received from the factory, after repair, and after receiving any abuse. The samplers should be calibrated in the laboratory both before they are used in the field and after they have been used to collect a large number of field samples. The primary standard, such as a spirometer or other standard calibrating instruments such as a wet test meter or a large bubble meter or dry gas meter, should be used. Instructions for calibration with the wet test meter follow. If another calibration device is selected, equivalent procedures should be used:

A. Level wet test meter. Check the water level which should just touch the calibration point at the left side of the meter. If water level is low, add water 1-2°F. warmer than room temperature of till point. Run the meter for 30 minutes before calibration;

B. Place the polyvinyl chloride membrane filter in the filter cassette;

C. Assemble the calibration sampling train;

D. Connect the wet test meter to the train;

The pointer on the meter should run clockwise and a pressure drop of not more than 1.0 inch of water indicated. If the pressure drop is greater than 1.0, disconnect and check the system;

E. Monitoring equipment for use in Class III hazardous locations must be approved for use in such locations, in accordance with the requirements of the OSHA electrical standards in Subpart S.

F. Check the vacuum gauge on the pump to insure that the pressure drop across the orifice exceeds 17 inches of mercury; 01

G. Record the following on calibration data sheets:

1. Wet test meter reading, start and finish;
2. Elapsed time, start and finish (at least two minutes);
3. Pressure drop at manometer;
4. Air temperature;
5. Barometric pressure; and
6. Limiting orifice number;

H. Calculate the flow rate and compare against the flow of 7.4±0.2 liters/minute. If flow is between these limits, perform calibration again, average results, and record orifice number and flow rate. If flow is not within these limits, discard or modify orifice and repeat procedure;

I. Record the name of the person performing the calibration, the date, serial number of the wet test meter, and the number of the critical orifices being calibrated.

IV. SAMPLING PROCEDURE

A. **Sampling data sheets should include a log of:**

1. The date of the sample collection;
2. The time of sampling;
3. The location of the sampler;
4. The sampler serial number;
5. The cassette number;
6. The time of starting and stopping the sampling and the duration of sampling;
7. The weight of the filter before and after sampling;
8. The weight of dust collected (corrected for controls);
9. The dust concentration measured;
10. Other pertinent information; and
11. Name of person taking sample.

B. **Assembly of filter cassette should be as follows:**

1. Loosely assemble 3-piece cassette;
2. Number cassette;
3. Place absorbent pad in cassette;
4. Weigh filter to an accuracy of 10 μg;
5. Place filter in cassette;
6. Record weight of filter in log, using cassette number for identification;
7. Fully assemble cassette, using pressure to force parts tightly together;
8. Install plugs top and bottom;
9. Put shrink band on cassette, covering joint between center and bottom parts of cassette; and
10. Set cassette aside until shrink band dries thoroughly.

C. **Sampling collection should be performed as follows:**

1. Clean lint out of the motor and elutriator;
2. Install vertical elutriator in sampling locations specified above with inlet 4½ to 5½ feet from floor (breathing zone height);
3. Remove top section of cassette;
4. Install cassette to ferrule of elutriator.
5. Tape cassette to ferrule with masking tape or similar material for air tight seal.
6. Remove bottom plug of cassette and attach hose containing critical orifice;
7. Start elutriator pump and check to see if gauge reads above 17 in. of Hg vacuum;
8. Record starting time, cassette number, and sampler number;
9. At end of sampling period stop pump and record time; and
10. Controls with each batch of samples collected, two additional filter cassettes should be subjected to exactly the same handling as the samples, except that they are not opened. These control filters should be weighed in the same manner as the sample filters.

Any difference in weight in the control filters would indicate that the procedure for handling sample filters may not be adequate and should be evaluated to ascertain the cause of the difference, whether and what necessary corrections must be made, and whether additional samples must be collected.

D. **Shipping.**

The cassette with samples should be collected, along with the appropriate number of blanks, and shipped to the analytical laboratory in a suitable container to prevent damage in transit.

E. **Weighing of the sample should be achieved as follows:**

1. Remove shrink band;
2. Remove top and middle sections of cassette and bottom plug;
3. Remove filter from cassette and weigh to an accuracy of 10 μg; and
4. Record weight in log against original weight.

F. **Calculation of volume of air sampled should be determined as follows:**

1. From starting and stopping times of sampling period, determine length of time in minutes of sampling period; and
2. Multiply sampling time in minutes by flow rate of critical orifice in liters per minute and divide by 1000 to find air quantity in cubic meters.

G. **Calculation of dust concentrations should be made as follows:**

1. Subtract weight of clean filter from dirty filter and apply control correction to find actual weight of sample. Record this weight (in μg) in log; and
2. Divide mass of sample in μg by air volume in cubic meters to find dust concentration in μg/m. Record in log.

APPENDIX B-1
RESPIRATORY QUESTIONNAIRE

A. IDENTIFICATION DATA

PLANT _____

NAME _____
(Surname)

_____
(First Name)

ADDRESS _____

_____

INTERVIEWER: 1 2 3 4 5 6 7 8 (12)

WORK SHIFT: 1st _____ 2nd _____ 3rd _____ (13)

SOCIAL SECURITY NO. _____

DATE OF INTERVIEW _____ / _____ / _____
(Day / Month (figures) / Year (last 2 digits))

DATE OF BIRTH _____ / _____ / _____

AGE _____ (8,9) SEX (M)____ (F)____ (10)

RACE [W] [N] [Ind.] [Other] (11)

STANDING HEIGHT _____ (14,15)

WEIGHT _____ (16,18)

PRESENT WORK AREA

If working in more than one specified work area, X area where most of the work shift is spent. If "other," but spending 25% of the work shift in one of the specified work areas, classify in that work area. If carding department employee, check area within that department where most of the work shift is spent (if in doubt, check "throughout"). For work areas such as spinning and weaving where many work rooms may be involved, be sure to check the specific work room to which employee is assigned — if he works in more than one work room within a department, classify as 7 (all) for that department.

	Workroom Number	(19) Open	(20) Pick	Area	(21) Card No.1	(22) No.2	(23) Spin	(24) Wind	(25) Twist	(26) Spool	(27) Warp	(28) Slash	(29) Weave	(30) Other
AT RISK (cotton and cotton blend)	1			Cards										
	2			Draw										
	3			Comb										
	4			Rove										
	5			Thru-out										
	6													
	7 (all)													
Control (synthetic and wool)	8													
Ex-worker (cotton)	9													

Use actual wording of each question. Put X in appropriate square after each question. When in doubt record "No." When no square, circle appropriate answer.

B. COUGH

Do you usually cough first thing in the morning? (on getting up)†
(Count a cough with first smoke or on "first going out of doors." Exclude clearing throat or a single cough.) Yes ____ No ____ (31)

Do you usually cough during the day or at night?
(Ignore an occasional cough.) Yes ____ No ____ (32)

If 'Yes' to either question (31-32):

Do you cough like this on most days for as much as three months a year? Yes ____ No ____ (33)

Do you cough on any particular day of the week? Yes ____ No ____ (34)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	
If 'Yes': Which day?	Mon.	Tues	Wed.	Thur.	Fri.	Sat.	Sun.	(35)

†These words are for subjects who work at night.

C. PHLEGM or alternative word to suit local custom.

Do you usually bring up any phlegm from your chest first thing in the morning? (on getting up)† (Count phlegm with the first smoke or on "first going out of doors." Exclude phlegm from the nose. Count swallowed phlegm.) Yes ____ No ____ (36)

Do you usually bring up any phlegm from your chest during the day or at night? (Accept twice or more.) Yes ____ No ____ (37)

If 'Yes' to either question (36-37):

Do you bring up phlegm like this on most days for as much as three months each year? Yes ____ No ____ (38)

If 'Yes' to question (33) or (38):

How long have you had this phlegm (cough)?
(Write in number of years)

(1) ☐ 2 years or less
(2) ☐ More than 2 years-9 years
(3) ☐ 10-19 years
(4) ☐ 20+ years (39)

†These words are for subjects who work at night.

D. CHEST ILLNESSES

In the past three years, have you had a period of (increased) ‡ cough and phlegm lasting for 3 weeks or more?

(1) ☐ No
(2) ☐ Yes, only one period
(3) ☐ Yes, two or more periods (40)

‡For subjects who usually have phlegm:

During the past 3 years, have you had any chest illness which has kept you off work, indoors at home or in bed? (For as long as one week, flu?) Yes ____ No ____ (41)

If 'Yes' to (41):

Did you bring up (more) phlegm than usual in any of these illnesses? Yes ____ No ____ (42)

If 'Yes' to (42):

During the past three years have you had:
Only one such illness with increased phlegm? (1) ☐ (43)
More than one such illness: (2) ☐ (44)

Br. Grade _____

Z

E. TIGHTNESS

Does your chest ever feel tight or your breathing become difficult? Yes ____ No ____ (45)

Is your chest tight or your breathing difficult on any particular day of the week? (after a week or 10 days away from the mill) Yes ____ No ____ (46)

	(3)	(4)	(5)	(6)	(7)	(8)	
If 'Yes': Which day?	Mon. (1) Sometimes	Tues. (2) Always	Wed.	Thur.	Fri.	Sat.	Sun. (47)

If 'Yes' Monday: At what time on Monday does your chest feel tight or your breathing difficult? (1) ☐ Before entering the mill (2) ☐ After entering the mill (48)

Ask only if NO to Question (45):

In the past, has your chest ever been tight or your breathing difficult on any particular day of the week? Yes ____ No ____ (49)

	(3)	(4)	(5)	(6)	(7)	(8)	
If 'Yes': Which day?	Mon. (1) Sometimes	Tues. (2) Always	Wed.	Thur.	Fri.	Sat.	Sun. (50)

F. BREATHLESSNESS

If disabled from walking by any condition other than heart or lung disease put "X" here and leave questions (52-60) unasked. ☐ (51)

Are you ever troubled by shortness of breath, when hurrying on the level or walking up a slight hill? Yes ____ No ____ (52)

If 'No', grade is 1. If 'Yes' proceed to next question

Do you get short of breath walking with other people at an ordinary pace on the level? Yes ____ No ____ (53)

If 'No', grade is 2. If 'Yes', proceed to next question

Do you have to stop for breath when walking at your own pace on the level? Yes ____ No ____ (54)

If 'No', grade is 3. If 'Yes', proceed to next question

Are you short of breath on washing or dressing? Yes ____ No ____ (55)

If 'No', grade is 4. If 'Yes', grade is 5.

Dyspnea Grd. _____ (56)

ON MONDAYS:

Are you ever troubled by shortness of breath, when hurrying on the level or walking up a slight hill? Yes ____ No ____ (57)

If 'No', grade is 1. If 'Yes', proceed to next question

Do you get short of breath walking with other people at an ordinary pace on the level? Yes ____ No ____ (58)

If 'No', grade is 2. If 'Yes', proceed to next question

Do you have to stop for breath when walking at your own pace on the level? Yes ____ No ____ (59)

If 'No', grade is 3. If 'Yes', proceed to next question

Are you short of breath on washing or dressing? Yes ____ No ____ (60)

If 'No', grade is 4. If 'Yes', grade is 5.

B. Grd. _____ (61)

G. OTHER ILLNESSES AND ALLERGY HISTORY

Do you have a heart condition for which you are under a doctor's care? Yes ____ No ____ (62)

Have you ever had asthma? Yes ____ No ____ (63)

If 'Yes', did it begin: (1) ☐ Before age 30
(2) ☐ After age 30

If 'Yes' before 30:

Did you have asthma before ever going to work in a textile mill? Yes ____ No ____ (64)

Have you ever had hay fever or other allergies (other than above)? Yes ____ No ____ (65)

H. TOBACCO SMOKING*

Do you smoke?

Record 'Yes' if regular smoker up to one month ago. (Cigarettes, cigars, or pipe) Yes ____ No ____ (66)

If 'No' to (63):

Have you ever smoked? (Cigarettes, cigars, pipe. Record 'No' if subject has never smoked as much as one cigarette a day, or 1 oz. of tobacco a month, for as long as one year.) Yes ____ No ____ (67)

If 'Yes' to (63) or (64):

What have you smoked and for how many years?
(Write in specific number of years in the appropriate square)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	
Years	(<5)	(5-9)	(10-14)	(15-19)	(20-24)	(25-29)	(30-34)	(35-39)	(>40)	
Cigarettes										(68)
Pipe										(69)
Cigars										(70)

If cigarettes, how many packs per day?
(Write in number of cigarettes)

(1) ☐ less than ½ pack
(2) ☐ ½ pack, but less than 1 pack
(3) ☐ 1 pack, but less than 1½ packs
(4) ☐ 1½ packs or more (71)

Number of pack years: _____ (72, 73)

If an ex-smoker (cigarettes, cigar or pipe,) how long since you stopped? (Write in number of years)

(1) ☐ 0-1 year
(2) ☐ 1-4 years
(3) ☐ 5-9 years
(4) ☐ 10+ years (74)

*Have you changed your smoking habits since last interview? If yes, specify what changes.

I. OCCUPATIONAL HISTORY**

Have you ever worked in: A foundry? (As long as one year) Yes ____ No ____ (75)

Stone or mineral mining, quarrying or processing? (As long as one year) Yes ____ No ____ (76)

Asbestos milling or processing? (Ever) Yes ____ No ____ (77)

Other dusts, fumes or smoke? If 'Yes', specify: Yes ____ No ____ (78)

Type of exposure _____
Length of exposure _____

At what age did you first go to work in a textile mill? (Write in specific age in appropriate square).

(1)	(2)	(3)	(4)	(5)	(6)	
<20	20-24	25-29	30-34	35-39	40+	
						(79)

When you first worked in a textile mill, did you work with (1) ☐ Cotton or cotton blend
(2) ☐ Synthetic or wool (80)

**Ask only on first interview.

Z

APPENDIX B-2

RESPIRATORY QUESTIONNAIRE FOR NON-TEXTILE WORKERS FOR THE COTTON INDUSTRY

Identification No.	Interviewer Code
Location	Date of Interview

A. IDENTIFICATION

1. NAME (Last) (First) (Middle Initial)	3. PHONE NUMBER Area Code ( ) No.	4. SOCIAL SECURITY NO. (Optional; see below*)
2. CURRENT ADDRESS (Number, Street or Rural Route, City or Town, County, State, Zip Code)	5. BIRTHDATE Mo./Day/Yr.	6. AGE LAST BIRTHDAY
	7. SEX 1. ☐ Male 2. ☐ Female	
	8. ETHNIC GROUP OR ANCESTRY 1. ☐ White, not of Hispanic Origin 2. ☐ Black, not of Hispanic Origin 3. ☐ Hispanic 4. ☐ American Indian or Alaskan Native 5. ☐ Asian or Pacific Islander 6. ☐ Other _____	
9. STANDING HEIGHT _____ (cm)	10. WEIGHT _____	11. WORK SHIFT 1 ☐ 2 ☐ 3 ☐

12. PRESENT WORK AREA
Please indicate primary assigned work area and percent of time spent at that site.
If at other locations, please indicate and note percent of time for each.

PRIMARY WORK AREA	
SPECIFIC JOB	

13. APPROPRIATE INDUSTRY

1. ☐ Garnetting
2. ☐ Cottonseed Oil Mill
3. ☐ Cotton Warehouse
4. ☐ Utilization
5. ☐ Cotton Classification
6. ☐ Cotton Ginning

* Furnishing your Social Security number is voluntary. Your refusal to provide this number will not affect any right, benefit or privilege to which you would be entitled if you did provide your Social Security number. Your Social Security number is being requested since it will permit use in future determinations in statistical research studies.

B. OCCUPATIONAL HISTORY TABLE

Complete the following table, showing the entire work history of the individual from present to initial employment. Sporadic, part-time periods of employment, each of no significant duration, should be grouped if possible.

INDUSTRY AND LOCATION	TENURE OF EMPLOYMENT		SPECIFIC OCCUPATION	AVERAGE NUMBER OF DAYS WORKED PER WEEK	HAZARDOUS HEALTH EXPOSURE ASSOCIATED WITH WORK		
	From 19__	To 19__			YES	NO	IF "YES," DESCRIBE

COMMENTS:

ADDITIONAL COMMENTS:

Z

C. SYMPTOMS

Use actual wording of each question. Put X in appropriate square after each question. When in doubt, record "No."

COUGH

1. Do you usually cough first thing in the morning (on getting up)†
   (Count a cough with first smoke or on "first going out of doors."
   Exclude clearing throat or a single cough.) — 1 ☐ Yes 2 ☐ No

2. Do you usually cough during the day or at night? (Ignore an occasional cough.) — 1 ☐ Yes 2 ☐ No

If YES to either question 1 or 2:

3. Do you cough like this on most days for as much as three months a year? — 1 ☐ Yes 2 ☐ No 9 ☐ NA

4. Do you cough on any particular day of the week? — 1 ☐ Yes 2 ☐ No

If YES:

5. Which day? Mon. Tue. Wed. Thur. Fri. Sat. Sun.

†These words are for subjects who work at night

PHLEGM

6. Do you bring up any phlegm from your chest first thing in the morning? (On getting up)†
   (Count phlegm with the first smoke or on "first going out of doors."
   Exclude phlegm from the nose. Count swallowed phlegm.) — 1 ☐ Yes 2 ☐ No

7. Do you usually bring up any phlegm from your chest during the day or at night? (Accept twice or more.) — 1 ☐ Yes 2 ☐ No

If YES to either question 6 or 7:

8. Do you bring up phlegm like this on most days for as much as three months each year? — 1 ☐ Yes 2 ☐ No

If YES to question 3 or 8:

9. How long have you had this phlegm (cough)? (Write in number of years.)
   1 ☐ 2 years or less
   2 ☐ More than 2 yrs — 9 yrs
   3 ☐ 10-19 yrs
   4 ☐ 20+ yrs

†These words are for subjects who work at night

CHEST ILLNESS

10. In the past three years, have you had a period of (increased) cough and phlegm lasting for 3 weeks or more?
    1 ☐ No
    2 ☐ Yes, only one period
    3 ☐ Yes, two or more periods

For subjects who usually have phlegm:

11. During the past three years have you had any chest illness which has kept you off work, indoors at home or in bed? (For as long as one week, flu?) — 1 ☐ Yes 2 ☐ No

If YES to 11:

12. Did you bring up (more) phlegm than usual in any of these illnesses? — 1 ☐ Yes 2 ☐ No

If YES to 12: During the past three years have you had:

13. Only one such illness with increased phlegm? 1 ☐ Yes 2 ☐ No

14. More than one such illness? 1 ☐ Yes 2 ☐ No

Br. Grade _____

TIGHTNESS

15. Does your chest ever feel tight or your breathing become difficult? 1 ☐ Yes 2 ☐ No

16. Is your chest tight or your breathing difficult on any particular day of the week? (After a week or 10 days away from the mill) 1 ☐ Yes 2 ☐ No

17. If YES: Which day? Mon. (1) Sometimes (2) Always Tue. (3) Wed. (4) Thur. (5) Fri. (6) Sat. (7) Sun. (8)

18. If YES Monday: At what time Monday does your chest feel tight or your breathing difficult?

☐ Before entering mill
☐ After entering mill

(ASK ONLY IF NO TO QUESTION 15):

19. In the past, has your chest ever been tight or your breathing difficult on any particular day of the week? 1 ☐ Yes 2 ☐ No

20. If YES: Which day? Mon. (1) Sometimes (2) Always Tue. (3) Wed. (4) Thur. (5) Fri. (6) Sat. (7) Sun. (8)

BREATHLESSNESS

21. If disabled from walking by any condition other than heart or lung disease, put "X" in the space and leave questions (22-30) unasked. ☐

22. Are you ever troubled by shortness of breath, when hurrying on the level or walking up a slight hill? 1 ☐ Yes 2 ☐ No

If NO, grade is 1. If YES, proceed to next question.

23. Do you get short of breath walking with other people at an ordinary pace on the level? 1 ☐ Yes 2 ☐ No

If NO, grade is 2. If YES, proceed to next question.

24. Do you have to stop for breath when walking at your own pace on the level? 1 ☐ Yes 2 ☐ No

If NO, grade is 3. If YES, proceed to next question.

25. Are you short of breath on washing or dressing? 1 ☐ Yes 2 ☐ No

If NO, grade is 4. If yes, grade is 5.

26. Dyspnea Grd _____

ON MONDAYS:

27. Are you ever troubled by shortness of breath, when hurrying on the level or walking up a slight hill? 1 ☐ Yes 2 ☐ No

If NO, grade is 1. If YES, proceed to next question.

28. Do you get short of breath walking with other people at an ordinary pace on the level? 1 ☐ Yes 2 ☐ No

If NO, grade is 2. If YES, proceed to next question.

29. Do you have to stop for breath when walking at your own pace on the level? 1 ☐ Yes 2 ☐ No

If NO, grade is 3. If YES, proceed to next question.

30. Are you short of breath on washing or dressing? 1 ☐ Yes 2 ☐ No

If NO, grade is 4. If YES, grade is 5.

31. B. Grd. _____

OTHER ILLNESSES AND ALLERGY HISTORY

32. Do you have a heart condition for which you are under a doctor's care? 1 ☐ Yes 2 ☐ No

33. Have you ever had asthma? 1 ☐ Yes 2 ☐ No

If yes, did it begin: (1) ☐ Before age 30
(2) ☐ After age 30

34. If yes before 30: Did you have asthma before ever going to work in a textile mill? 1 ☐ Yes 2 ☐ No

35. Have you ever had hay fever or other allergies (other than above)? 1 ☐ Yes 2 ☐ No

TOBACCO SMOKING

36. Do you smoke? Record YES if regular smoker up to one month ago (Cigarettes, cigar or pipe). 1 ☐ Yes 2 ☐ No

If NO to 33:

37. Have you ever smoked? (Cigarettes, cigars or pipe. Record NO if subject has never smoked as much as one cigarette a day, or 1 oz. of tobacco a month, for as long as one year.) 1 ☐ Yes 2 ☐ No

If YES to 33 or 34: What have you smoked for how many years? (Write in specific number of years in the appropriate square.)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Years	(<5)	(5-9)	(10-14)	(15-19)	(20-24)	(25-29)	(30-34)	(35-39)	(>40)
38. Cigarettes									
39. Pipe									
40. Cigars									

41. If cigarettes, how many packs per day?
Write in number of cigarettes: _____

☐ Less than 1/2 pack
☐ 1/2 pack, but less than 1 pack
☐ 1 pack, but less than 1-1/2 packs
☐ 1-1/2 packs or more

42. Number of pack years: _____

43. If an ex-smoker (cigarettes, cigars or pipe), how long since you stopped? (Write in number of years.) _____

☐ 0-1 year
☐ 1-4 years
☐ 5-9 years
☐ 10+ years

OCCUPATIONAL HISTORY

Have you ever worked in:

44. A foundry? (As long as one year) 1 ☐ Yes 2 ☐ No

45. Stone or mineral mining, quarrying or processing? (As long as one year) 1 ☐ Yes 2 ☐ No

46. Asbestos milling or processing? (Ever) 1 ☐ Yes 2 ☐ No

47. Cotton or cotton blend mill? (For controls only) 1 ☐ Yes 2 ☐ No

48. Other dusts, fumes or smoke? 1 ☐ Yes 2 ☐ No

If YES, specify: Type of exposure _____

Length of exposure _____

RESPIRATORY QUESTIONNAIRE
(SPANISH LANGUAGE VERSION OF APPENDIX B-2)

CUESTIONARIO RESPIRATORIO PARA TRABAJADORES QUE NO SEAN DE TEXTIL DE LA INDUSTRIA ALGODONERA

Numero de indentificación	Clave del entrevistador
Localidad	Fecha de entrevista

A. IDENTIFICACIÓN

1. NOMBRE (Apellido) (Nombre de pila)	3. Núm. de telefono Area ( )	4. Núm. de Seguro Social*
2. DIRECCIÓN ACTUAL (Número, Calle, Ciudad ó Pueblo, Condado, Estado, Zona Postal)	5. Fecha de Nacimiento Mes/Dia/Año	6. Edad
	7. SEXO 1. ☐ Varón 2. ☐ Hembra	
	8. RAZA 1. ☐ Blanco, no de origen hispano 2. ☐ Negro, no de origen hispano 3. ☐ Hispano 4. ☐ Indio Americano ó Nativo de Alaska 5. ☐ Asíatico ó de islas pacificas 6. ☐ Otro _____	
9. ALTURA MEDIDA _____ (cm)	10. PESO MEDIDO _____	11. TURNO DE TRABAJO 1 ☐ 2 ☐ 3 ☐

12. SITIO DE TRABAJO ACTUAL

Indiqué el sitio de trabajo asignado y el porcentaje de tiempo que pasa en ese lugar. Si trabaja en otros sitios, por favor indiqué esos lugares y el porcentaje de tiempo que pasa en cada uno.

SITIO DE TRABAJO PRIMARIO	
TRABAJO ESPECIFICO	

13. INDUSTRIA APROPIADA

1. ☐ Desperdicios de maquina garnet
2. ☐ Fabrica de aceite de semilla de algodón
3. ☐ Almacen de algodón
4. ☐ Utilización
5. ☐ Clasificacion de algodó
6. ☐ Desmotador

* Proveer su número de seguro social es voluntario. El rehuso de proveer este número no afecta ningun derecho, beneficio, ó privilegio al cual Ud. podría tener derecho. Su número de seguro social ha sido requerido desde que este permite el uso de determinaciones en el futuro en la busqueda de estudios estaticales.

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B. TABLA DE HISTORIA LABORAL

Llene la siguiente tabla indicando la historia del individuo desde que lo primero empleo hasta el presente. Periodos de empleo aislados ó de tiempo parcial deben ser agrupados si es possible.

INDUSTRIA Y LOCAL	TIEMPO DE EMPLEO		TRABAJO ESPECIFICO	PROMEDIO DEL NUM. DE DIAS TRAB. POR SEM.	RIESGO DE SALUD POR CONTACTO ASOCIADO CON EL TRABAJO		
	Desde 19__	Hasta 19__			SÍ	NO	Si se contesta "SÍ" expliquese

COMENTARIOS:

Z

C. SINTOMAS

Empléense las palabras exactas de cada pregunta. Póngase una "x" en la casilla que sigue cada pregunta. En case do duda, póngase "No." Donde no hay casilla, póngase un circulo alrededor de la repuesta apropiada.

LA TOS

1. ¿Tose Ud. ordinariamente al levantarse por la mañana? (Tenga en eventa la flema arrancada al fumos ó al salar de la casa por primera vez. No tenga en eventa los mucos nasales.) — 1. ☐ Sí 2. ☐ No

2. ¿Tose Ud. ordinariamente de día ó de noche? — 1. ☐ Sí 2. ☐ No

Si se contesta "Sí" a las preguntas 1 ó 2, pregúntese:

3. ¿Tose así la mayoría de los días por un periodo de por lo menos 3 meses durante el pasado año? — 1. ☐ Sí 2. ☐ No

4. ¿Tose Ud. mas de lo ordinario algún día en particular de la semana? — 1. ☐ Sí 2. ☐ No

Si se contesta "Sí," pregúntese:

5. ¿Que día? Lun. Mar. Mier. Jue. Vie. Sab. Dom.

LA FLEMA

6. ¿Se arranca Ud. flema ó catarro del pecho al levantarse? (Tenga en cuenta la flema arrancada al fumar ó al salir de la casa por primera vez. No tenga en cuenta los mucos nasales. Tenga en cuenta la flema que se traga.) — 1. ☐ Sí 2. ☐ No

7. ¿Se arranca Ud. flema ó catarro del pecho ordinariamente de día ó de noche? (Nótense solo 2 veces ó mas.) — 1. ☐ Sí 2. ☐ No

8. ¿Arroja Ud. flemas así la mayor parte de días tanto como tres meses al año? — 1. ☐ Sí 2. ☐ No

Si se contesta "Sí" a las preguntas 3 ó 8, pregúntese:

9. ¿Cuantos años hace que se arranca flema ó catarro ó tose frequentemente? (Responda en números de años.)
   1. ☐ 2 años o menos
   2. ☐ mas de 2 años — 9 años
   3. ☐ 10-19 años
   4. ☐ 20 años o mas

ENFERMEDADES PULMONARIAS

10. ¿Durante los tres años pasados, ha pasado algún periodo de tos* y flemas que duró 3 semanas ó mas?
    *Sujetos que ordinariamente se arrancan flemas
    - ☐ No
    - ☐ Sí, un solo periodo
    - ☐ Sí, dos periodos ó mas

11. ¿Ha tenido Ud. durante los 3 años pasados alguna enfermedad del pecho que le haya impedido a trabajar ó obligado a permanecer en casa ó en cama por tanto como una semana? (Por ejemplo, ¿la gripe?) — ☐ Sí ☐ No

Si se contesta "Sí" a la pregunta 11, pregúntese:

12. ¿Se arrancó Ud. mas flemas que lo general durante alguno de estos ataques? — ☐ Sí ☐ No

Si se contesta "Sí" a 12, pregúntese:

13. ¿Ha tenido durante los tres años pasados:
    Solo un tal ataque con aumento de flemas? — ☐ Sí ☐ No

14. Mas de uno? — ☐ Sí ☐ No

Br. Grade _____

LA OPRESIÓN DEL PECHO

15. ¿Ha tenido Ud. alguna vez opresión en el pecho ó dificultadad en respirar? ☐ Sí ☐ No

16. ¿Se le oprime el pecho ó se le hace dificil respirar algún día en la semana en particular? (Despues de una semana ó 10 días de ausencia de la planta) ☐ Sí ☐ No

17. Si se contesta "Sí": ¿Que día?

Lun. Mar. Mier. Jue. Vie. Sab. Dom. Siempre A veces

18. Si se contesta "Sí" para los lunes, pregúntese:
¿A que hora del lunes siente opresión en el pecho ó dificultadad en respirar?

a. ☐ Antes de entrar en la desmotadora
b. ☐ Despues de entrar en la desmotadora
c. ☐ Despues de salir de la desmotadora

(Pregúntese solo si se contesta "No" a la 15:)

19. ¿En el pasado, se le ha oprimido el pecho ó hecho dificil respirar algún día de la semana en particular? ☐ Sí ☐ No

20. Si se contesta "Sí": ¿Que día?

Lun. Mar. Mier. Jue. Vie. Sab. Dom. Siempre A veces

EL DESALIENTO (La Dispnea)

21. Si se inhabilita de caminar a causa de cualquier condición que no sea enfermedad del corazon ó de los pulmones, ponga una "x" y ignore las preguntas 22-30. ☐

22. ¿Lo aflige un desaliento al caminar aprisa en terreno llano ó al subir una pequeña cuesta? ☐ Sí ☐ No

(Si "No," el grado es 1. Si es "Sí," siga a la proxima pregunta.)

23. ¿Lo aflige un desaliento al caminar con otros de su propia edad a su paso ordinario en terreno llano? ☐ Sí ☐ No

(Si "No," el grado es 2. Si es "Sí," prosiga.)

24. ¿Tiene que detenerse porque se ahoga al caminar a paso ordinario en terreno llano? ☐ Sí ☐ No

(Si "No," el grado es 3. Si es "Sí," prosiga.)

25. ¿Se desalienta al lavarse ó vestirse? ☐ Sí ☐ No

(Si "No," el grado es 4. Si es "Sí," el grado es 5.

26. Dyspnea Grd. _____

LOS LUNES: EL PRIMER DIA DE VUELTA AL TRABAJO DESPUES DE SUS DIAS LIBRES

27. ¿Lo aflige un desaliento al caminar aprisa en terreno llano ó al subir una pequeña cuesta? ☐ Sí ☐ No

(Si "No," el grado es 1. Si es "Sí," siga a la proxima pregunta.)

28. ¿Lo aflige un desaliento al caminar con otros de su propia edad a su paso ordinario en terreno llano? ☐ Sí ☐ No

(Si "No," el grado es 2. Si es "Sí," prosiga.)

29. ¿Tiene que detenerse porque se ahoga al caminar a paso ordinario en terreno llano? ☐ Sí ☐ No

(Si "No," el grado es 3. Si es "Sí," prosiga.)

30. ¿Se desalienta al lavarse ó vestirse? ☐ Sí ☐ No

(Si "No," el grado es 4. Si es "Sí," el grado es 5.)

31. Br. Grd. _____

Z

OTRAS ENFERMEDADES

32. ¿Tiene Ud. una condición del corazon que requiere los servicios de un medico? ☐ Sí ☐ No

33. ¿Ha tenido alguna vez asma? ☐ Sí ☐ No

Si se contesta "Sí" a la 33, pregúntese si empezo: ☐ Antes de los 30 años ☐ Despues de los 30 años

34. Si se contesta "Antes de los 30 años": ¿Tenia Ud. asma antes de trabajar en una desmotadora de algodón? ☐ Sí ☐ No

35. ¿Ha tenido alguna vez otras alergias (ademas de las de arriba)? ☐ Sí ☐ No

CONSUMO DE TABACO

36. ¿Fuma Ud. actualmente? Indiqué "Sí" si fumaba regularmente hasta hace un mes (Cigarrillos, puros, ó pipa). ☐ Sí ☐ No

Si contesta "No" a la 33, pregúntese:

37. ¿Ha fumado Ud. alguna vez (cigarrillos, puros, ó pipa)? Indiqué "No" si el sujeto nunca ha fumado ni un cigarrillo diario ó una onza de tabaco al mes, por un año. ☐ Sí ☐ No

Si se contesta "Sí" a la 33 ó 34: ¿que ha fumado Ud. y por cuantos años? (Indiqué el número especifico de años en la casilla apropiada.)

	Años	(< 5)	(5-9)	(10-14)	(15-19)	(20-24)	(25-29)	(30-34)	(35-39)	(> 40)
38.	Cigarrillos									
39.	Pipa									
40.	Puros									

41. ¿Si fuma cigarrillos, cuantas cajetillas fuma diarias? Indiqué en número de cigarrillos:
- ☐ menos de 1/2 cajetilla
- ☐ 1/2 cajetilla, pero menos de 1
- ☐ 1 cajetilla, pero menos de 1-1/2
- ☐ 1-1/2 cajetillas ó mas

42. Número de cajetillas por año: _____

43. Si ha dejado de fumar (cigarrillos, pipas, ó puros): ¿cuanto tiempo hace que lo dejó? (Indiqué en número de años.)
- ☐ 0 - 1 año
- ☐ 1 - 4 años
- ☐ 5 - 9 años
- ☐ 10 años ó mas

HISTORIA LABORAL

¿Ha trabajado Ud. alguna vez en:

44. Una fundación (por tanto como un año)? ☐ Sí ☐ No

45. La minería ó elaboración de piedras ó metales (por tanto como un año)? ☐ Sí ☐ No

46. En una planta de asbesto (alguna vez)? ☐ Sí ☐ No

47. En una fabrica de algodón ó de mezclado de algodón? ☐ Sí ☐ No

48. En proximidad de otros polvos, emanaciones ó humos? ☐ Sí ☐ No

Si se contesta "Sí," especifíquese: Clase de contacto _____

Duración de contacto _____

APPENDIX B-3

ABBREVIATED RESPIRATORY QUESTIONNAIRE

A. IDENTIFICATION DATA

PLANT _____

NAME _____
(Surname)

_____
(First Name)

ADDRESS _____

_____

INTERVIEWER: 1 2 3 4 5 6 7 8 (12)

WORK SHIFT: 1st _____ 2nd _____ 3rd _____ (13)

SOCIAL SECURITY NO. _____

DATE OF INTERVIEW _____ / _____ / _____
(Day / Month (figures) / Year (last 2 digits))

DATE OF BIRTH _____ / _____ / _____

AGE _____ (8,9) SEX (M)____ (F)____ (10)

RACE [W] [N] [Ind.] [Other] (11)

STANDING HEIGHT _____ (14,15)

WEIGHT _____ (16,18)

PRESENT WORK AREA

If working in more than one specified work area, X area where most of the work shift is spent. If "other," but spending 25% of the work shift in one of the specified work areas, classify in that work area. If carding department employee, check area within that department where most of the work shift is spent (if in doubt, check "throughout"). For work areas such as spinning and weaving where many work rooms may be involved, be sure to check the specific work room to which employee is assigned — if he works in more than one work room within a department, classify as 7 (all) for that department.

	Workroom Number	(19) Open	(20) Pick	Area	(21) Card No.1	(22) No.2	(23) Spin	(24) Wind	(25) Twist	(26) Spool	(27) Warp	(28) Slash	(29) Weave	(30) Other
AT RISK (cotton and cotton blend)	1			Cards										
	2			Draw										
	3			Comb										
	4			Rove										
	5			Thru-out										
	6													
	7 (all)													
Control (synthetic and wool)	8													
Ex-worker (cotton)	9													

Z

Use actual wording of each question. Put X in appropriate square after each question. When in doubt record "No." When no square, circle appropriate answer.

B. COUGH

Do you usually cough first thing in the morning? (on getting up)† (Count a cough with first smoke or on "first going out of doors." Exclude clearing throat or a single cough.) Yes ____ No ____ (31)

Do you usually cough during the day or at night? (Ignore an occasional cough.) Yes ____ No ____ (32)

If 'Yes' to either question (31-32):

Do you cough like this on most days for as much as three months a year? Yes ____ No ____ (33)

Do you cough on any particular day of the week? Yes ____ No ____ (34)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	
If 'Yes': Which day?	Mon.	Tues	Wed.	Thur.	Fri.	Sat.	Sun.	(35)

†These words are for subjects who work at night.

C. PHLEGM or alternative word to suit local custom.

Do you usually bring up any phlegm from your chest first thing in the morning? (on getting up)† (Count phlegm with the first smoke or on "first going out of doors." Exclude phlegm from the nose. Count swallowed phlegm.) Yes ____ No ____ (36)

Do you usually bring up any phlegm from your chest during the day or at night? (Accept twice or more.) Yes ____ No ____ (37)

If 'Yes' to either question (36-37):

Do you bring up phlegm like this on most days for as much as three months each year? Yes ____ No ____ (38)

If 'Yes' to question (33) or (38):

How long have you had this phlegm (cough)? (Write in number of years)

(1) ☐ 2 years or less
(2) ☐ More than 2 years-9 years
(3) ☐ 10-19 years
(4) ☐ 20+ years

†These words are for subjects who work at night.

D. TIGHTNESS

Does your chest ever feel tight or your breathing become difficult? Yes ____ No ____ (39)

Is your chest tight or your breathing difficult on any particular day of the week? (after a week or 10 days away from the mill) Yes ____ No ____ (40)

		(3)	(4)	(5)	(6)	(7)	(8)	
If 'Yes': Which day?	Mon.	Tues.	Wed.	Thur.	Fri.	Sat.	Sun.	(41)
	(1) Sometimes	(2) Always						

If 'Yes' Monday: At what time on Monday does your chest feel tight or your breathing difficult?

(1) ☐ Before entering the mill
(2) ☐ After entering the mill (42)

Ask only if NO to Question (45):

In the past, has your chest ever been tight or your breathing difficult on any particular day of the week? Yes ____ No ____ (43)

		(3)	(4)	(5)	(6)	(7)	(8)	
If 'Yes': Which day?	Mon.	Tues.	Wed.	Thur.	Fri.	Sat.	Sun.	(44)
	(1) Sometimes	(2) Always						

E. TOBACCO SMOKING*

*Have you changed your smoking habits since last interview? If yes, specify what changes.

APPENDIX C

SPIROMETRY PREDICTION TABLES FOR NORMAL MALES AND FEMALES

TABLE 1 – PREDICTED FVC FOR MALES (KNUDSON, ET AL: AM REV RESPIR DIS, 1976, 113, 587.)

HT	AGE 17	19	21	23	25	27	29	31	33	35	37	39	41	43	45	47	49	51	53	55	57	59	61	63	65
60.0	3.44	3.59	3.75	3.91	3.72	3.66	3.61	3.55	3.49	3.43	3.37	3.32	3.26	3.20	3.14	3.08	3.03	2.97	2.91	2.85	2.79	2.74	2.68	2.62	2.56
60.5	3.50	3.66	3.81	3.97	3.80	3.75	3.69	3.63	3.57	3.51	3.46	3.40	3.34	3.28	3.22	3.17	3.11	3.05	2.99	2.93	2.88	2.82	2.76	2.70	2.64
61.0	3.56	3.72	3.88	4.03	3.89	3.83	3.77	3.71	3.66	3.60	3.54	3.48	3.42	3.37	3.31	3.25	3.19	3.13	3.08	3.02	2.96	2.90	2.84	2.79	2.73
61.5	3.63	3.78	3.94	4.10	3.97	3.91	3.85	3.80	3.74	3.68	3.62	3.56	3.51	3.45	3.39	3.33	3.27	3.22	3.16	3.10	3.04	2.98	2.93	2.87	2.81
62.0	3.69	3.85	4.00	4.16	4.05	3.99	3.94	3.88	3.82	3.76	3.70	3.65	3.59	3.53	3.47	3.41	3.36	3.30	3.24	3.18	3.12	3.07	3.01	2.95	2.89
62.5	3.76	3.91	4.07	4.22	4.13	4.08	4.02	3.96	3.90	3.84	3.79	3.73	3.67	3.61	3.55	3.50	3.44	3.38	3.32	3.26	3.21	3.15	3.09	3.03	2.97
63.0	3.82	3.97	4.13	4.29	4.22	4.16	4.10	4.04	3.99	3.93	3.87	3.81	3.75	3.70	3.64	3.58	3.52	3.46	3.41	3.35	3.29	3.23	3.17	3.12	3.06
63.5	3.88	4.04	4.19	4.35	4.30	4.24	4.18	4.13	4.07	4.01	3.95	3.89	3.84	3.78	3.72	3.66	3.60	3.55	3.49	3.43	3.37	3.31	3.26	3.20	3.14
64.0	3.95	4.10	4.26	4.41	4.38	4.32	4.27	4.21	4.15	4.09	4.03	3.98	3.92	3.86	3.80	3.74	3.69	3.63	3.57	3.51	3.45	3.40	3.34	3.28	3.22
64.5	4.01	4.17	4.32	4.48	4.46	4.41	4.35	4.29	4.23	4.17	4.12	4.06	4.00	3.94	3.88	3.83	3.77	3.71	3.65	3.59	3.54	3.48	3.42	3.36	3.30
65.0	4.07	4.23	4.39	4.54	4.55	4.49	4.43	4.37	4.32	4.26	4.20	4.14	4.08	4.03	3.97	3.91	3.85	3.79	3.74	3.68	3.62	3.56	3.50	3.45	3.39
65.5	4.14	4.29	4.45	4.60	4.63	4.57	4.51	4.46	4.40	4.34	4.28	4.22	4.17	4.11	4.05	3.99	3.93	3.88	3.82	3.76	3.70	3.64	3.59	3.53	3.47
66.0	4.20	4.36	4.51	4.67	4.71	4.65	4.60	4.54	4.48	4.42	4.36	4.31	4.25	4.19	4.13	4.07	4.02	3.96	3.90	3.84	3.78	3.73	3.67	3.61	3.55
66.5	4.26	4.42	4.58	4.73	4.80	4.74	4.68	4.62	4.56	4.51	4.45	4.39	4.33	4.27	4.22	4.16	4.10	4.04	3.98	3.93	3.87	3.81	3.75	3.69	3.64
67.0	4.33	4.48	4.64	4.80	4.88	4.82	4.76	4.70	4.65	4.59	4.53	4.47	4.41	4.36	4.30	4.24	4.18	4.12	4.07	4.01	3.95	3.89	3.83	3.78	3.72
67.5	4.39	4.55	4.70	4.86	4.96	4.90	4.84	4.79	4.73	4.67	4.61	4.55	4.50	4.44	4.38	4.32	4.26	4.21	4.15	4.09	4.03	3.97	3.92	3.86	3.80
68.0	4.45	4.61	4.77	4.92	5.04	4.98	4.93	4.87	4.81	4.75	4.69	4.64	4.58	4.52	4.46	4.40	4.35	4.29	4.23	4.17	4.11	4.06	4.00	3.94	3.88
68.5	4.52	4.67	4.83	4.99	5.13	5.07	5.01	4.95	4.89	4.84	4.78	4.72	4.66	4.60	4.55	4.49	4.43	4.37	4.31	4.26	4.20	4.14	4.08	4.02	3.97
69.0	4.58	4.74	4.89	5.05	5.21	5.15	5.09	5.03	4.98	4.92	4.86	4.80	4.74	4.69	4.63	4.57	4.51	4.45	4.40	4.34	4.28	4.22	4.16	4.11	4.05
69.5	4.64	4.80	4.96	5.11	5.29	5.23	5.17	5.12	5.06	5.00	4.94	4.88	4.83	4.77	4.71	4.65	4.59	4.54	4.48	4.42	4.36	4.30	4.25	4.19	4.13
70.0	4.71	4.86	5.02	5.18	5.37	5.32	5.26	5.20	5.14	5.08	5.02	4.97	4.91	4.85	4.79	4.74	4.68	4.62	4.56	4.50	4.44	4.39	4.33	4.27	4.21
70.5	4.77	4.93	5.08	5.24	5.46	5.40	5.34	5.28	5.22	5.17	5.11	5.05	4.99	4.93	4.88	4.82	4.76	4.70	4.64	4.59	4.53	4.47	4.41	4.35	4.30
71.0	4.83	4.99	5.15	5.30	5.54	5.48	5.42	5.36	5.31	5.25	5.19	5.13	5.07	5.02	4.96	4.90	4.84	4.78	4.73	4.67	4.61	4.55	4.49	4.44	4.38
71.5	4.90	5.05	5.21	5.37	5.62	5.56	5.50	5.45	5.39	5.33	5.27	5.21	5.16	5.10	5.04	4.98	4.92	4.87	4.81	4.75	4.69	4.63	4.58	4.52	4.46
72.0	4.96	5.12	5.27	5.43	5.70	5.65	5.59	5.53	5.47	5.41	5.36	5.30	5.24	5.18	5.12	5.07	5.01	4.95	4.89	4.83	4.78	4.72	4.66	4.60	4.54
72.5	5.03	5.18	5.34	5.49	5.79	5.73	5.67	5.61	5.55	5.50	5.44	5.38	5.32	5.26	5.21	5.15	5.09	5.03	4.97	4.92	4.86	4.80	4.74	4.68	4.63
73.0	5.09	5.24	5.40	5.56	5.87	5.81	5.75	5.69	5.64	5.58	5.52	5.46	5.40	5.35	5.29	5.23	5.17	5.11	5.06	5.00	4.94	4.88	4.82	4.77	4.71
73.5	5.15	5.31	5.46	5.62	5.95	5.89	5.83	5.78	5.72	5.66	5.60	5.54	5.49	5.43	5.37	5.31	5.25	5.20	5.14	5.08	5.02	4.96	4.91	4.85	4.79
74.0	5.22	5.37	5.53	5.68	6.03	5.98	5.92	5.86	5.80	5.74	5.69	5.63	5.57	5.51	5.45	5.40	5.34	5.28	5.22	5.16	5.11	5.05	4.99	4.93	4.87
74.5	5.28	5.44	5.59	5.75	6.12	6.06	6.00	5.94	5.88	5.83	5.77	5.71	5.65	5.59	5.54	5.48	5.42	5.36	5.30	5.25	5.19	5.13	5.07	5.01	4.96
75.0	5.34	5.50	5.65	5.81	6.20	6.14	6.08	6.02	5.97	5.91	5.85	5.79	5.73	5.68	5.62	5.56	5.50	5.44	5.39	5.33	5.27	5.21	5.15	5.10	5.04
75.5	5.41	5.56	5.72	5.87	6.28	6.22	6.17	6.11	6.05	5.99	5.93	5.88	5.82	5.76	5.70	5.64	5.59	5.53	5.47	5.41	5.35	5.30	5.24	5.18	5.12
76.0	5.47	5.63	5.78	5.94	6.36	6.31	6.25	6.19	6.13	6.07	6.02	5.96	5.90	5.84	5.78	5.73	5.67	5.61	5.55	5.49	5.44	5.38	5.32	5.26	5.20
76.5	5.53	5.69	5.85	6.00	6.45	6.39	6.33	6.27	6.21	6.16	6.10	6.04	5.98	5.92	5.87	5.81	5.75	5.69	5.63	5.58	5.52	5.46	5.40	5.34	5.29
77.0	5.60	5.75	5.91	6.06	6.53	6.47	6.41	6.35	6.30	6.24	6.18	6.12	6.06	6.01	5.95	5.89	5.83	5.77	5.72	5.66	5.60	5.54	5.48	5.43	5.37
77.5	5.66	5.82	5.97	6.13	6.61	6.55	6.50	6.44	6.38	6.32	6.26	6.21	6.15	6.09	6.03	5.97	5.92	5.86	5.80	5.74	5.68	5.63	5.57	5.51	5.45
78.0	5.72	5.88	6.04	6.19	6.69	6.64	6.58	6.52	6.46	6.40	6.35	6.29	6.23	6.17	6.11	6.06	6.00	5.94	5.88	5.82	5.77	5.71	5.65	5.59	5.53
78.5	5.79	5.94	6.10	6.26	6.78	6.72	6.66	6.60	6.54	6.49	6.43	6.37	6.31	6.25	6.20	6.14	6.08	6.02	5.96	5.91	5.85	5.79	5.73	5.67	5.62
79.0	5.85	6.01	6.16	6.32	6.86	6.80	6.74	6.68	6.63	6.57	6.51	6.45	6.39	6.34	6.28	6.22	6.16	6.10	6.05	5.99	5.93	5.87	5.81	5.76	5.70
79.5	5.91	6.07	6.23	6.38	6.94	6.88	6.83	6.77	6.71	6.65	6.59	6.54	6.48	6.42	6.36	6.30	6.25	6.19	6.13	6.07	6.01	5.96	5.90	5.84	5.78
80.0	5.98	6.13	6.29	6.45	7.02	6.97	6.91	6.85	6.79	6.73	6.68	6.62	6.56	6.50	6.44	6.39	6.33	6.27	6.21	6.15	6.10	6.04	5.98	5.92	5.86
80.5	6.04	6.20	6.35	6.51	7.11	7.05	6.99	6.93	6.87	6.82	6.76	6.70	6.64	6.58	6.53	6.47	6.41	6.35	6.29	6.24	6.18	6.12	6.06	6.00	5.95
81.0	6.10	6.26	6.42	6.57	7.19	7.13	7.07	7.02	6.96	6.90	6.84	6.78	6.73	6.67	6.61	6.55	6.49	6.44	6.38	6.32	6.26	6.20	6.15	6.09	6.03
81.5	6.17	6.32	6.48	6.64	7.27	7.21	7.16	7.10	7.04	6.98	6.92	6.87	6.81	6.75	6.69	6.63	6.58	6.52	6.46	6.40	6.34	6.29	6.23	6.17	6.11
82.0	6.23	6.39	6.54	6.70	7.35	7.30	7.24	7.18	7.12	7.06	7.01	6.95	6.89	6.83	6.77	6.72	6.66	6.60	6.54	6.48	6.43	6.37	6.31	6.25	6.19
82.5	6.30	6.45	6.61	6.76	7.44	7.38	7.32	7.26	7.20	7.15	7.09	7.03	6.97	6.91	6.86	6.80	6.74	6.68	6.62	6.57	6.51	6.45	6.39	6.33	6.28
83.0	6.36	6.51	6.67	6.83	7.52	7.46	7.40	7.35	7.29	7.23	7.17	7.11	7.06	7.00	6.94	6.88	6.82	6.77	6.71	6.65	6.59	6.53	6.48	6.42	6.36
83.5	6.42	6.58	6.73	6.89	7.60	7.54	7.49	7.43	7.37	7.31	7.25	7.20	7.14	7.08	7.02	6.96	6.91	6.85	6.79	6.73	6.67	6.62	6.56	6.50	6.44
84.0	6.49	6.64	6.80	6.95	7.68	7.63	7.57	7.51	7.45	7.39	7.34	7.28	7.22	7.16	7.10	7.05	6.99	6.93	6.87	6.81	6.76	6.70	6.64	6.58	6.52
84.5	6.55	6.71	6.86	7.02	7.77	7.71	7.65	7.59	7.53	7.48	7.42	7.36	7.30	7.24	7.19	7.13	7.07	7.01	6.95	6.90	6.84	6.78	6.72	6.66	6.61
85.0	6.61	6.77	6.92	7.08	7.85	7.79	7.73	7.68	7.62	7.56	7.50	7.44	7.39	7.33	7.27	7.21	7.15	7.10	7.04	6.98	6.92	6.86	6.81	6.75	6.69

TABLE 2 – PREDICTED FEV_1 FOR MALES (KNUDSON, ET AL: AM REV RESPIR DIS, 1976, 113, 587.)

HT	AGE 17	19	21	23	25	27	29	31	33	35	37	39	41	43	45	47	49	51	53	55	57	59	61	63	65
60.0	2.97	3.06	3.15	3.24	3.05	2.99	2.94	2.88	2.83	2.78	2.72	2.67	2.61	2.56	2.51	2.45	2.40	2.34	2.29	2.24	2.18	2.13	2.07	2.02	1.97
60.5	3.03	3.12	3.21	3.30	3.11	3.06	3.00	2.95	2.90	2.84	2.79	2.73	2.68	2.63	2.57	2.52	2.46	2.41	2.36	2.30	2.25	2.19	2.14	2.09	2.03
61.0	3.08	3.17	3.26	3.35	3.18	3.12	3.07	3.02	2.96	2.91	2.85	2.80	2.75	2.69	2.64	2.58	2.53	2.48	2.42	2.37	2.31	2.26	2.21	2.15	2.10
61.5	3.14	3.23	3.32	3.41	3.24	3.19	3.14	3.08	3.03	2.97	2.92	2.87	2.81	2.76	2.70	2.65	2.60	2.54	2.49	2.43	2.38	2.33	2.27	2.22	2.16
62.0	3.20	3.29	3.38	3.47	3.31	3.26	3.20	3.15	3.09	3.04	2.99	2.93	2.88	2.82	2.77	2.72	2.66	2.61	2.55	2.50	2.45	2.39	2.34	2.28	2.23
62.5	3.26	3.35	3.44	3.53	3.38	3.32	3.27	3.22	3.16	3.11	3.05	3.00	2.95	2.89	2.84	2.78	2.73	2.68	2.62	2.57	2.51	2.46	2.41	2.35	2.30
63.0	3.32	3.41	3.50	3.59	3.44	3.39	3.34	3.28	3.23	3.17	3.12	3.07	3.01	2.96	2.90	2.85	2.80	2.74	2.69	2.63	2.58	2.53	2.47	2.42	2.36
63.5	3.38	3.47	3.56	3.65	3.51	3.46	3.40	3.35	3.29	3.24	3.19	3.13	3.08	3.02	2.97	2.92	2.86	2.81	2.75	2.70	2.65	2.59	2.54	2.48	2.43
64.0	3.43	3.52	3.61	3.70	3.58	3.52	3.47	3.41	3.36	3.31	3.25	3.20	3.14	3.09	3.04	2.98	2.93	2.87	2.82	2.77	2.71	2.66	2.60	2.55	2.50
64.5	3.49	3.58	3.67	3.76	3.64	3.59	3.53	3.48	3.43	3.37	3.32	3.26	3.21	3.16	3.10	3.05	2.99	2.94	2.89	2.83	2.78	2.72	2.67	2.62	2.56
65.0	3.55	3.64	3.73	3.82	3.71	3.65	3.60	3.55	3.49	3.44	3.38	3.33	3.28	3.22	3.17	3.11	3.06	3.01	2.95	2.90	2.84	2.79	2.74	2.68	2.63
65.5	3.61	3.70	3.79	3.88	3.77	3.72	3.67	3.61	3.56	3.50	3.45	3.40	3.34	3.29	3.23	3.18	3.13	3.07	3.02	2.96	2.91	2.86	2.80	2.75	2.69
66.0	3.67	3.76	3.85	3.94	3.84	3.79	3.73	3.68	3.62	3.57	3.52	3.46	3.41	3.35	3.30	3.25	3.19	3.14	3.08	3.03	2.98	2.92	2.87	2.81	2.76
66.5	3.73	3.82	3.91	4.00	3.91	3.85	3.80	3.74	3.69	3.64	3.58	3.53	3.47	3.42	3.37	3.31	3.26	3.20	3.15	3.10	3.04	2.99	2.93	2.88	2.83
67.0	3.79	3.88	3.97	4.06	3.97	3.92	3.86	3.81	3.76	3.70	3.65	3.59	3.54	3.49	3.43	3.38	3.32	3.27	3.22	3.16	3.11	3.05	3.00	2.95	2.89
67.5	3.84	3.93	4.02	4.11	4.04	3.98	3.93	3.88	3.82	3.77	3.71	3.66	3.61	3.55	3.50	3.44	3.39	3.34	3.28	3.23	3.17	3.12	3.07	3.01	2.96
68.0	3.90	3.99	4.08	4.17	4.10	4.05	4.00	3.94	3.89	3.83	3.78	3.73	3.67	3.62	3.56	3.51	3.46	3.40	3.35	3.29	3.24	3.19	3.13	3.08	3.02
68.5	3.96	4.05	4.14	4.23	4.17	4.12	4.06	4.01	3.95	3.90	3.85	3.79	3.74	3.68	3.63	3.58	3.52	3.47	3.41	3.36	3.31	3.25	3.20	3.14	3.09
69.0	4.02	4.11	4.20	4.29	4.24	4.18	4.13	4.07	4.02	3.97	3.91	3.86	3.80	3.75	3.70	3.64	3.59	3.53	3.48	3.43	3.37	3.32	3.26	3.21	3.16
69.5	4.08	4.17	4.26	4.35	4.30	4.25	4.19	4.14	4.09	4.03	3.98	3.92	3.87	3.82	3.76	3.71	3.65	3.60	3.55	3.49	3.44	3.38	3.33	3.28	3.22
70.0	4.14	4.23	4.32	4.41	4.37	4.31	4.26	4.21	4.15	4.10	4.04	3.99	3.94	3.88	3.83	3.77	3.72	3.67	3.61	3.56	3.50	3.45	3.40	3.34	3.29
70.5	4.19	4.28	4.37	4.46	4.43	4.38	4.33	4.27	4.22	4.16	4.11	4.06	4.00	3.95	3.89	3.84	3.79	3.73	3.68	3.62	3.57	3.52	3.46	3.41	3.35
71.0	4.25	4.34	4.43	4.52	4.50	4.45	4.39	4.34	4.28	4.23	4.18	4.12	4.07	4.01	3.96	3.91	3.85	3.80	3.74	3.69	3.64	3.58	3.53	3.47	3.42
71.5	4.31	4.40	4.49	4.58	4.57	4.51	4.46	4.40	4.35	4.30	4.24	4.19	4.13	4.08	4.03	3.97	3.92	3.86	3.81	3.76	3.70	3.65	3.59	3.54	3.49
72.0	4.37	4.46	4.55	4.64	4.63	4.58	4.52	4.47	4.42	4.36	4.31	4.25	4.20	4.15	4.09	4.04	3.98	3.93	3.88	3.82	3.77	3.71	3.66	3.61	3.55
72.5	4.43	4.52	4.61	4.70	4.70	4.64	4.59	4.54	4.48	4.43	4.37	4.32	4.27	4.21	4.16	4.10	4.05	4.00	3.94	3.89	3.83	3.78	3.73	3.67	3.62
73.0	4.49	4.58	4.67	4.76	4.76	4.71	4.66	4.60	4.55	4.49	4.44	4.39	4.33	4.28	4.22	4.17	4.12	4.06	4.01	3.95	3.90	3.85	3.79	3.74	3.68
73.5	4.54	4.63	4.72	4.81	4.83	4.78	4.72	4.67	4.61	4.56	4.51	4.45	4.40	4.34	4.29	4.24	4.18	4.13	4.07	4.02	3.97	3.91	3.86	3.80	3.75
74.0	4.60	4.69	4.78	4.87	4.90	4.84	4.79	4.73	4.68	4.63	4.57	4.52	4.46	4.41	4.36	4.30	4.25	4.19	4.14	4.09	4.03	3.98	3.92	3.87	3.82
74.5	4.66	4.75	4.84	4.93	4.96	4.91	4.85	4.80	4.75	4.69	4.64	4.58	4.53	4.48	4.42	4.37	4.31	4.26	4.21	4.15	4.10	4.04	3.99	3.94	3.88
75.0	4.72	4.81	4.90	4.99	5.03	4.97	4.92	4.87	4.81	4.76	4.70	4.65	4.60	4.54	4.49	4.43	4.38	4.33	4.27	4.22	4.16	4.11	4.06	4.00	3.95
75.5	4.78	4.87	4.96	5.05	5.09	5.04	4.99	4.93	4.88	4.82	4.77	4.72	4.66	4.61	4.55	4.50	4.45	4.39	4.34	4.28	4.23	4.18	4.12	4.07	4.01
76.0	4.84	4.93	5.02	5.11	5.16	5.11	5.05	5.00	4.94	4.89	4.84	4.78	4.73	4.67	4.62	4.57	4.51	4.46	4.40	4.35	4.30	4.24	4.19	4.13	4.08
76.5	4.90	4.99	5.08	5.17	5.23	5.17	5.12	5.06	5.01	4.96	4.90	4.85	4.79	4.74	4.69	4.63	4.58	4.52	4.47	4.42	4.36	4.31	4.25	4.20	4.15
77.0	4.95	5.04	5.13	5.22	5.29	5.24	5.18	5.13	5.08	5.02	4.97	4.91	4.86	4.81	4.75	4.70	4.64	4.59	4.54	4.48	4.43	4.37	4.32	4.27	4.21
77.5	5.01	5.10	5.19	5.28	5.36	5.30	5.25	5.20	5.14	5.09	5.03	4.98	4.93	4.87	4.82	4.76	4.71	4.66	4.60	4.55	4.49	4.44	4.39	4.33	4.28
78.0	5.07	5.16	5.25	5.34	5.42	5.37	5.32	5.26	5.21	5.15	5.10	5.05	4.99	4.94	4.88	4.83	4.78	4.72	4.67	4.61	4.56	4.51	4.45	4.40	4.34
78.5	5.13	5.22	5.31	5.40	5.49	5.44	5.38	5.33	5.27	5.22	5.17	5.11	5.06	5.00	4.95	4.90	4.84	4.79	4.73	4.68	4.63	4.57	4.52	4.46	4.41
79.0	5.19	5.28	5.37	5.46	5.56	5.50	5.45	5.39	5.34	5.29	5.23	5.18	5.12	5.07	5.02	4.96	4.91	4.85	4.80	4.75	4.69	4.64	4.58	4.53	4.48
79.5	5.25	5.34	5.43	5.52	5.62	5.57	5.51	5.46	5.41	5.35	5.30	5.24	5.19	5.14	5.08	5.03	4.97	4.92	4.87	4.81	4.76	4.70	4.65	4.60	4.54
80.0	5.30	5.39	5.48	5.57	5.69	5.63	5.58	5.53	5.47	5.42	5.36	5.31	5.26	5.20	5.15	5.09	5.04	4.99	4.93	4.88	4.82	4.77	4.72	4.66	4.61
80.5	5.36	5.45	5.54	5.63	5.75	5.70	5.65	5.59	5.54	5.48	5.43	5.38	5.32	5.27	5.21	5.16	5.11	5.05	5.00	4.94	4.89	4.84	4.78	4.73	4.67
81.0	5.42	5.51	5.60	5.69	5.82	5.77	5.71	5.66	5.60	5.55	5.50	5.44	5.39	5.33	5.28	5.23	5.17	5.12	5.06	5.01	4.96	4.90	4.85	4.79	4.74
81.5	5.48	5.57	5.66	5.75	5.89	5.83	5.78	5.72	5.67	5.62	5.56	5.51	5.45	5.40	5.35	5.29	5.24	5.18	5.13	5.08	5.02	4.97	4.91	4.86	4.81
82.0	5.54	5.63	5.72	5.81	5.95	5.90	5.84	5.79	5.74	5.68	5.63	5.57	5.52	5.47	5.41	5.36	5.30	5.25	5.20	5.14	5.09	5.03	4.98	4.93	4.87
82.5	5.60	5.69	5.78	5.87	6.02	5.96	5.91	5.86	5.80	5.75	5.69	5.64	5.59	5.53	5.48	5.42	5.37	5.32	5.26	5.21	5.15	5.10	5.05	4.99	4.94
83.0	5.65	5.74	5.83	5.92	6.08	6.03	5.98	5.92	5.87	5.81	5.76	5.71	5.65	5.60	5.54	5.49	5.44	5.38	5.33	5.27	5.22	5.17	5.11	5.06	5.00
83.5	5.71	5.80	5.89	5.98	6.15	6.10	6.04	5.99	5.93	5.88	5.83	5.77	5.72	5.66	5.61	5.56	5.50	5.45	5.39	5.34	5.29	5.23	5.18	5.12	5.07
84.0	5.77	5.86	5.95	6.04	6.22	6.16	6.11	6.05	6.00	5.95	5.89	5.84	5.78	5.73	5.68	5.62	5.57	5.51	5.46	5.41	5.35	5.30	5.24	5.19	5.14
84.5	5.83	5.92	6.01	6.10	6.28	6.23	6.17	6.12	6.07	6.01	5.96	5.90	5.85	5.80	5.74	5.69	5.63	5.58	5.53	5.47	5.42	5.36	5.31	5.26	5.20
85.0	5.89	5.98	6.07	6.16	6.35	6.29	6.24	6.19	6.13	6.08	6.02	5.97	5.92	5.86	5.81	5.75	5.70	5.65	5.59	5.54	5.48	5.43	5.38	5.32	5.27

TABLE 3 – PREDICTED FVC FOR FEMALES (KNUDSON, ET AL: AM REV RESPIR DIS, 1976, 113, 587.)

HT	AGE 17	19	21	23	25	27	29	31	33	35	37	39	41	43	45	47	49	51	53	55	57	59	61	63	65
52.0	2.45	2.64	2.65	2.61	2.56	2.52	2.47	2.43	2.39	2.34	2.30	2.25	2.21	2.17	2.12	2.08	2.03	1.99	1.95	1.90	1.86	1.81	1.77	1.73	1.68
52.5	2.50	2.68	2.70	2.65	2.61	2.57	2.52	2.48	2.43	2.39	2.35	2.30	2.26	2.21	2.17	2.13	2.08	2.04	1.99	1.95	1.91	1.86	1.82	1.77	1.73
53.0	2.54	2.72	2.74	2.70	2.66	2.61	2.57	2.52	2.48	2.44	2.39	2.35	2.30	2.26	2.22	2.17	2.13	2.08	2.04	2.00	1.95	1.91	1.86	1.82	1.78
53.5	2.58	2.76	2.79	2.75	2.70	2.66	2.62	2.57	2.53	2.48	2.44	2.40	2.35	2.31	2.26	2.22	2.18	2.13	2.09	2.04	2.00	1.96	1.91	1.87	1.82
54.0	2.62	2.81	2.84	2.79	2.75	2.71	2.66	2.62	2.57	2.53	2.49	2.44	2.40	2.35	2.31	2.27	2.22	2.18	2.13	2.09	2.05	2.00	1.96	1.91	1.87
54.5	2.66	2.85	2.89	2.84	2.80	2.75	2.71	2.67	2.62	2.58	2.53	2.49	2.45	2.40	2.36	2.31	2.27	2.23	2.18	2.14	2.09	2.05	2.01	1.96	1.92
55.0	2.71	2.89	2.93	2.89	2.84	2.80	2.76	2.71	2.67	2.62	2.58	2.54	2.49	2.45	2.40	2.36	2.32	2.27	2.23	2.18	2.14	2.10	2.05	2.01	1.96
55.5	2.75	2.93	2.98	2.94	2.89	2.85	2.80	2.76	2.72	2.67	2.63	2.58	2.54	2.50	2.45	2.41	2.36	2.32	2.28	2.23	2.19	2.14	2.10	2.06	2.01
56.0	2.79	2.97	3.03	2.98	2.94	2.89	2.85	2.81	2.76	2.72	2.67	2.63	2.59	2.54	2.50	2.45	2.41	2.37	2.32	2.28	2.23	2.19	2.15	2.10	2.06
56.5	2.83	3.01	3.07	3.03	2.99	2.94	2.90	2.85	2.81	2.77	2.72	2.68	2.63	2.59	2.55	2.50	2.46	2.41	2.37	2.33	2.28	2.24	2.19	2.15	2.11
57.0	2.87	3.06	3.12	3.08	3.03	2.99	2.94	2.90	2.86	2.81	2.77	2.72	2.68	2.64	2.59	2.55	2.50	2.46	2.42	2.37	2.33	2.28	2.24	2.20	2.15
57.5	2.91	3.10	3.17	3.12	3.08	3.04	2.99	2.95	2.90	2.86	2.82	2.77	2.73	2.68	2.64	2.60	2.55	2.51	2.46	2.42	2.38	2.33	2.29	2.24	2.20
58.0	2.96	3.14	3.21	3.17	3.13	3.08	3.04	2.99	2.95	2.91	2.86	2.82	2.77	2.73	2.69	2.64	2.60	2.55	2.51	2.47	2.42	2.38	2.33	2.29	2.25
58.5	3.00	3.18	3.26	3.22	3.17	3.13	3.09	3.04	3.00	2.95	2.91	2.87	2.82	2.78	2.73	2.69	2.65	2.60	2.56	2.51	2.47	2.43	2.38	2.34	2.29
59.0	3.04	3.22	3.31	3.26	3.22	3.18	3.13	3.09	3.04	3.00	2.96	2.91	2.87	2.82	2.78	2.74	2.69	2.65	2.60	2.56	2.52	2.47	2.43	2.38	2.34
59.5	3.08	3.27	3.36	3.31	3.27	3.22	3.18	3.14	3.09	3.05	3.00	2.96	2.92	2.87	2.83	2.78	2.74	2.70	2.65	2.61	2.56	2.52	2.48	2.43	2.39
60.0	3.12	3.31	3.40	3.36	3.31	3.27	3.23	3.18	3.14	3.09	3.05	3.01	2.96	2.92	2.87	2.83	2.79	2.74	2.70	2.65	2.61	2.57	2.52	2.48	2.43
60.5	3.17	3.35	3.45	3.41	3.36	3.32	3.27	3.23	3.19	3.14	3.10	3.05	3.01	2.97	2.92	2.88	2.83	2.79	2.75	2.70	2.66	2.61	2.57	2.53	2.48
61.0	3.21	3.39	3.50	3.45	3.41	3.36	3.32	3.28	3.23	3.19	3.14	3.10	3.06	3.01	2.97	2.92	2.88	2.84	2.79	2.75	2.70	2.66	2.62	2.57	2.53
61.5	3.25	3.43	3.54	3.50	3.46	3.41	3.37	3.32	3.28	3.24	3.19	3.15	3.10	3.06	3.02	2.97	2.93	2.88	2.84	2.80	2.75	2.71	2.66	2.62	2.58
62.0	3.29	3.48	3.59	3.55	3.50	3.46	3.41	3.37	3.33	3.28	3.24	3.19	3.15	3.11	3.06	3.02	2.97	2.93	2.89	2.84	2.80	2.75	2.71	2.67	2.62
62.5	3.33	3.52	3.64	3.59	3.55	3.51	3.46	3.42	3.37	3.33	3.29	3.24	3.20	3.15	3.11	3.07	3.02	2.98	2.93	2.89	2.85	2.80	2.76	2.71	2.67
63.0	3.38	3.56	3.68	3.64	3.60	3.55	3.51	3.46	3.42	3.38	3.33	3.29	3.24	3.20	3.16	3.11	3.07	3.02	2.98	2.94	2.89	2.85	2.80	2.76	2.72
63.5	3.42	3.60	3.73	3.69	3.64	3.60	3.56	3.51	3.47	3.42	3.38	3.34	3.29	3.25	3.20	3.16	3.12	3.07	3.03	2.98	2.94	2.90	2.85	2.81	2.76
64.0	3.46	3.64	3.78	3.73	3.69	3.65	3.60	3.56	3.51	3.47	3.43	3.38	3.34	3.29	3.25	3.21	3.16	3.12	3.07	3.03	2.99	2.94	2.90	2.85	2.81
64.5	3.50	3.69	3.83	3.78	3.74	3.69	3.65	3.61	3.56	3.52	3.47	3.43	3.39	3.34	3.30	3.25	3.21	3.17	3.12	3.08	3.03	2.99	2.95	2.90	2.86
65.0	3.54	3.73	3.87	3.83	3.78	3.74	3.70	3.65	3.61	3.56	3.52	3.48	3.43	3.39	3.34	3.30	3.26	3.21	3.17	3.12	3.08	3.04	2.99	2.95	2.90
65.5	3.59	3.77	3.92	3.88	3.83	3.79	3.74	3.70	3.66	3.61	3.57	3.52	3.48	3.44	3.39	3.35	3.30	3.26	3.22	3.17	3.13	3.08	3.04	3.00	2.95
66.0	3.63	3.81	3.97	3.92	3.88	3.83	3.79	3.75	3.70	3.66	3.61	3.57	3.53	3.48	3.44	3.39	3.35	3.31	3.26	3.22	3.17	3.13	3.09	3.04	3.00
66.5	3.67	3.85	4.01	3.97	3.93	3.88	3.84	3.79	3.75	3.71	3.66	3.62	3.57	3.53	3.49	3.44	3.40	3.35	3.31	3.27	3.22	3.18	3.13	3.09	3.05
67.0	3.71	3.89	4.06	4.02	3.97	3.93	3.88	3.84	3.80	3.75	3.71	3.66	3.62	3.58	3.53	3.49	3.44	3.40	3.36	3.31	3.27	3.22	3.18	3.14	3.09
67.5	3.75	3.94	4.11	4.06	4.02	3.98	3.93	3.89	3.84	3.80	3.76	3.71	3.67	3.62	3.58	3.54	3.49	3.45	3.40	3.36	3.32	3.27	3.23	3.18	3.14
68.0	3.79	3.98	4.15	4.11	4.07	4.02	3.98	3.93	3.89	3.85	3.80	3.76	3.71	3.67	3.63	3.58	3.54	3.49	3.45	3.41	3.36	3.32	3.27	3.23	3.19
68.5	3.84	4.02	4.20	4.16	4.11	4.07	4.03	3.98	3.94	3.89	3.85	3.81	3.76	3.72	3.67	3.63	3.59	3.54	3.50	3.45	3.41	3.37	3.32	3.28	3.23
69.0	3.88	4.06	4.25	4.20	4.16	4.12	4.07	4.03	3.98	3.94	3.90	3.85	3.81	3.76	3.72	3.68	3.63	3.59	3.54	3.50	3.46	3.41	3.37	3.32	3.28
69.5	3.92	4.10	4.30	4.25	4.21	4.16	4.12	4.08	4.03	3.99	3.94	3.90	3.86	3.81	3.77	3.72	3.68	3.64	3.59	3.55	3.50	3.46	3.42	3.37	3.33
70.0	3.96	4.15	4.34	4.30	4.25	4.21	4.17	4.12	4.08	4.03	3.99	3.95	3.90	3.86	3.81	3.77	3.73	3.68	3.64	3.59	3.55	3.51	3.46	3.42	3.37
70.5	4.00	4.19	4.39	4.35	4.30	4.26	4.21	4.17	4.13	4.08	4.04	3.99	3.95	3.91	3.86	3.82	3.77	3.73	3.69	3.64	3.60	3.55	3.51	3.47	3.42
71.0	4.05	4.23	4.44	4.39	4.35	4.30	4.26	4.22	4.17	4.13	4.08	4.04	4.00	3.95	3.91	3.86	3.82	3.78	3.73	3.69	3.64	3.60	3.56	3.51	3.47
71.5	4.09	4.27	4.48	4.44	4.40	4.35	4.31	4.26	4.22	4.18	4.13	4.09	4.04	4.00	3.96	3.91	3.87	3.82	3.78	3.74	3.69	3.65	3.60	3.56	3.52
72.0	4.13	4.31	4.53	4.49	4.44	4.40	4.35	4.31	4.27	4.22	4.18	4.13	4.09	4.05	4.00	3.96	3.91	3.87	3.83	3.78	3.74	3.69	3.65	3.61	3.56
72.5	4.17	4.36	4.58	4.53	4.49	4.45	4.40	4.36	4.31	4.27	4.23	4.18	4.14	4.09	4.05	4.01	3.96	3.92	3.87	3.83	3.79	3.74	3.70	3.65	3.61
73.0	4.21	4.40	4.62	4.58	4.54	4.49	4.45	4.40	4.36	4.32	4.27	4.23	4.18	4.14	4.10	4.05	4.01	3.96	3.92	3.88	3.83	3.79	3.74	3.70	3.66
73.5	4.26	4.44	4.67	4.63	4.58	4.54	4.50	4.45	4.41	4.36	4.32	4.28	4.23	4.19	4.14	4.10	4.06	4.01	3.97	3.92	3.88	3.84	3.79	3.75	3.70
74.0	4.30	4.48	4.72	4.67	4.63	4.59	4.54	4.50	4.45	4.41	4.37	4.32	4.28	4.23	4.19	4.15	4.10	4.06	4.01	3.97	3.93	3.88	3.84	3.79	3.75
74.5	4.34	4.52	4.77	4.72	4.68	4.63	4.59	4.55	4.50	4.46	4.41	4.37	4.33	4.28	4.24	4.19	4.15	4.11	4.06	4.02	3.97	3.93	3.89	3.84	3.80
75.0	4.38	4.57	4.81	4.77	4.72	4.68	4.64	4.59	4.55	4.50	4.46	4.42	4.37	4.33	4.28	4.24	4.20	4.15	4.11	4.06	4.02	3.98	3.93	3.89	3.84
75.5	4.42	4.61	4.86	4.82	4.77	4.73	4.68	4.64	4.60	4.55	4.51	4.46	4.42	4.38	4.33	4.29	4.24	4.20	4.16	4.11	4.07	4.02	3.98	3.94	3.89
76.0	4.47	4.65	4.91	4.86	4.82	4.77	4.73	4.69	4.64	4.60	4.55	4.51	4.47	4.42	4.38	4.33	4.29	4.25	4.20	4.16	4.11	4.07	4.03	3.98	3.94
76.5	4.51	4.69	4.95	4.91	4.87	4.82	4.78	4.73	4.69	4.65	4.60	4.56	4.51	4.47	4.43	4.38	4.34	4.29	4.25	4.21	4.16	4.12	4.07	4.03	3.99
77.0	4.55	4.73	5.00	4.96	4.91	4.87	4.82	4.78	4.74	4.69	4.65	4.60	4.56	4.52	4.47	4.43	4.38	4.34	4.30	4.25	4.21	4.16	4.12	4.08	4.03

TABLE 4 – PREDICTED FEV_1 FOR FEMALES (KNUDSON, ET AL: AM REV RESPIR DIS, 1976, 113, 587.)

HT	AGE 17	19	21	23	25	27	29	31	33	35	37	39	41	43	45	47	49	51	53	55	57	59	61	63	65
52.0	2.31	2.48	2.33	2.29	2.25	2.21	2.16	2.12	2.08	2.04	2.00	1.95	1.91	1.87	1.83	1.79	1.74	1.70	1.66	1.62	1.58	1.53	1.49	1.45	1.41
52.5	2.34	2.51	2.37	2.32	2.28	2.24	2.20	2.16	2.11	2.07	2.03	1.99	1.95	1.90	1.86	1.82	1.78	1.74	1.69	1.65	1.61	1.57	1.53	1.48	1.44
53.0	2.38	2.55	2.40	2.36	2.32	2.27	2.23	2.19	2.15	2.11	2.06	2.02	1.98	1.94	1.90	1.85	1.81	1.77	1.73	1.69	1.64	1.60	1.56	1.52	1.48
53.5	2.41	2.58	2.43	2.39	2.35	2.31	2.27	2.22	2.18	2.14	2.10	2.06	2.01	1.97	1.93	1.89	1.85	1.80	1.76	1.72	1.68	1.64	1.59	1.55	1.51
54.0	2.45	2.62	2.47	2.43	2.38	2.34	2.30	2.26	2.22	2.17	2.13	2.09	2.05	2.01	1.96	1.92	1.88	1.84	1.80	1.75	1.71	1.67	1.63	1.59	1.54
54.5	2.48	2.65	2.50	2.46	2.42	2.38	2.33	2.29	2.25	2.21	2.17	2.12	2.08	2.04	2.00	1.96	1.91	1.87	1.83	1.79	1.75	1.70	1.66	1.62	1.58
55.0	2.51	2.68	2.54	2.49	2.45	2.41	2.37	2.33	2.28	2.24	2.20	2.16	2.12	2.07	2.03	1.99	1.95	1.91	1.86	1.82	1.78	1.74	1.70	1.65	1.61
55.5	2.55	2.72	2.57	2.53	2.49	2.45	2.40	2.36	2.32	2.28	2.24	2.19	2.15	2.11	2.07	2.03	1.98	1.94	1.90	1.86	1.82	1.77	1.73	1.69	1.65
56.0	2.58	2.75	2.61	2.56	2.52	2.48	2.44	2.40	2.35	2.31	2.27	2.23	2.19	2.14	2.10	2.06	2.02	1.98	1.93	1.89	1.85	1.81	1.77	1.72	1.68
56.5	2.62	2.79	2.64	2.60	2.56	2.51	2.47	2.43	2.39	2.35	2.30	2.26	2.22	2.18	2.14	2.09	2.05	2.01	1.97	1.93	1.88	1.84	1.80	1.76	1.72
57.0	2.65	2.82	2.67	2.63	2.59	2.55	2.51	2.46	2.42	2.38	2.34	2.30	2.25	2.21	2.17	2.13	2.09	2.04	2.00	1.96	1.92	1.88	1.83	1.79	1.75
57.5	2.69	2.86	2.71	2.67	2.62	2.58	2.54	2.50	2.46	2.41	2.37	2.33	2.29	2.25	2.20	2.16	2.12	2.08	2.04	1.99	1.95	1.91	1.87	1.83	1.78
58.0	2.72	2.89	2.74	2.70	2.66	2.62	2.57	2.53	2.49	2.45	2.41	2.36	2.32	2.28	2.24	2.20	2.15	2.11	2.07	2.03	1.99	1.94	1.90	1.86	1.82
58.5	2.75	2.92	2.78	2.73	2.69	2.65	2.61	2.57	2.52	2.48	2.44	2.40	2.36	2.31	2.27	2.23	2.19	2.15	2.10	2.06	2.02	1.98	1.94	1.89	1.85
59.0	2.79	2.96	2.81	2.77	2.73	2.69	2.64	2.60	2.56	2.52	2.48	2.43	2.39	2.35	2.31	2.27	2.22	2.18	2.14	2.10	2.06	2.01	1.97	1.93	1.89
59.5	2.82	2.99	2.85	2.80	2.76	2.72	2.68	2.64	2.59	2.55	2.51	2.47	2.43	2.38	2.34	2.30	2.26	2.22	2.17	2.13	2.09	2.05	2.01	1.96	1.92
60.0	2.86	3.03	2.88	2.84	2.80	2.75	2.71	2.67	2.63	2.59	2.54	2.50	2.46	2.42	2.38	2.33	2.29	2.25	2.21	2.17	2.12	2.08	2.04	2.00	1.96
60.5	2.89	3.06	2.91	2.87	2.83	2.79	2.75	2.70	2.66	2.62	2.58	2.54	2.49	2.45	2.41	2.37	2.33	2.28	2.24	2.20	2.16	2.12	2.07	2.03	1.99
61.0	2.93	3.10	2.95	2.91	2.86	2.82	2.78	2.74	2.70	2.65	2.61	2.57	2.53	2.49	2.44	2.40	2.36	2.32	2.28	2.23	2.19	2.15	2.11	2.07	2.02
61.5	2.96	3.13	2.98	2.94	2.90	2.86	2.81	2.77	2.73	2.69	2.65	2.60	2.56	2.52	2.48	2.44	2.39	2.35	2.31	2.27	2.23	2.18	2.14	2.10	2.06
62.0	2.99	3.16	3.02	2.97	2.93	2.89	2.85	2.81	2.76	2.72	2.68	2.64	2.60	2.55	2.51	2.47	2.43	2.39	2.34	2.30	2.26	2.22	2.18	2.13	2.09
62.5	3.03	3.20	3.05	3.01	2.97	2.93	2.88	2.84	2.80	2.76	2.72	2.67	2.63	2.59	2.55	2.51	2.46	2.42	2.38	2.34	2.30	2.25	2.21	2.17	2.13
63.0	3.06	3.23	3.09	3.04	3.00	2.96	2.92	2.88	2.83	2.79	2.75	2.71	2.67	2.62	2.58	2.54	2.50	2.46	2.41	2.37	2.33	2.29	2.25	2.20	2.16
63.5	3.10	3.27	3.12	3.08	3.04	2.99	2.95	2.91	2.87	2.83	2.78	2.74	2.70	2.66	2.62	2.57	2.53	2.49	2.45	2.41	2.36	2.32	2.28	2.24	2.20
64.0	3.13	3.30	3.15	3.11	3.07	3.03	2.99	2.94	2.90	2.86	2.82	2.78	2.73	2.69	2.65	2.61	2.57	2.52	2.48	2.44	2.40	2.36	2.31	2.27	2.23
64.5	3.17	3.34	3.19	3.15	3.10	3.06	3.02	2.98	2.94	2.89	2.85	2.81	2.77	2.73	2.68	2.64	2.60	2.56	2.52	2.47	2.43	2.39	2.35	2.31	2.26
65.0	3.20	3.37	3.22	3.18	3.14	3.10	3.05	3.01	2.97	2.93	2.89	2.84	2.80	2.76	2.72	2.68	2.63	2.59	2.55	2.51	2.47	2.42	2.38	2.34	2.30
65.5	3.23	3.40	3.26	3.21	3.17	3.13	3.09	3.05	3.00	2.96	2.92	2.88	2.84	2.79	2.75	2.71	2.67	2.63	2.58	2.54	2.50	2.46	2.42	2.37	2.33
66.0	3.27	3.44	3.29	3.25	3.21	3.17	3.12	3.08	3.04	3.00	2.96	2.91	2.87	2.83	2.79	2.75	2.70	2.66	2.62	2.58	2.54	2.49	2.45	2.41	2.37
66.5	3.30	3.47	3.33	3.28	3.24	3.20	3.16	3.12	3.07	3.03	2.99	2.95	2.91	2.86	2.82	2.78	2.74	2.70	2.65	2.61	2.57	2.53	2.49	2.44	2.40
67.0	3.34	3.51	3.36	3.32	3.28	3.23	3.19	3.15	3.11	3.07	3.02	2.98	2.94	2.90	2.86	2.81	2.77	2.73	2.69	2.65	2.60	2.56	2.52	2.48	2.44
67.5	3.37	3.54	3.39	3.35	3.31	3.27	3.23	3.18	3.14	3.10	3.06	3.02	2.97	2.93	2.89	2.85	2.81	2.76	2.72	2.68	2.64	2.60	2.55	2.51	2.47
68.0	3.41	3.58	3.43	3.39	3.34	3.30	3.26	3.22	3.18	3.13	3.09	3.05	3.01	2.97	2.92	2.88	2.84	2.80	2.76	2.71	2.67	2.63	2.59	2.55	2.50
68.5	3.44	3.61	3.46	3.42	3.38	3.34	3.29	3.25	3.21	3.17	3.13	3.08	3.04	3.00	2.96	2.92	2.87	2.83	2.79	2.75	2.71	2.66	2.62	2.58	2.54
69.0	3.47	3.64	3.50	3.46	3.41	3.37	3.33	3.29	3.25	3.20	3.16	3.12	3.08	3.04	2.99	2.95	2.91	2.87	2.83	2.78	2.74	2.70	2.66	2.62	2.57
69.5	3.51	3.68	3.53	3.49	3.45	3.41	3.36	3.32	3.28	3.24	3.20	3.15	3.11	3.07	3.03	2.99	2.94	2.90	2.86	2.82	2.78	2.73	2.69	2.65	2.61
70.0	3.54	3.71	3.57	3.52	3.48	3.44	3.40	3.36	3.31	3.27	3.23	3.19	3.15	3.10	3.06	3.02	2.98	2.94	2.89	2.85	2.81	2.77	2.73	2.68	2.64
70.5	3.58	3.75	3.60	3.56	3.52	3.47	3.43	3.39	3.35	3.31	3.26	3.22	3.18	3.14	3.10	3.05	3.01	2.97	2.93	2.89	2.84	2.80	2.76	2.72	2.68
71.0	3.61	3.78	3.63	3.59	3.55	3.51	3.47	3.42	3.38	3.34	3.30	3.26	3.21	3.17	3.13	3.09	3.05	3.00	2.96	2.92	2.88	2.84	2.79	2.75	2.71
71.5	3.65	3.82	3.67	3.63	3.58	3.54	3.50	3.46	3.42	3.37	3.33	3.29	3.25	3.21	3.16	3.12	3.08	3.04	3.00	2.95	2.91	2.87	2.83	2.79	2.74
72.0	3.68	3.85	3.70	3.66	3.62	3.58	3.53	3.49	3.45	3.41	3.37	3.32	3.28	3.24	3.20	3.16	3.11	3.07	3.03	2.99	2.95	2.90	2.86	2.82	2.78
72.5	3.71	3.88	3.74	3.70	3.65	3.61	3.57	3.53	3.49	3.44	3.40	3.36	3.32	3.28	3.23	3.19	3.15	3.11	3.07	3.02	2.98	2.94	2.90	2.86	2.81
73.0	3.75	3.92	3.77	3.73	3.69	3.65	3.60	3.56	3.52	3.48	3.44	3.39	3.35	3.31	3.27	3.23	3.18	3.14	3.10	3.06	3.02	2.97	2.93	2.89	2.85
73.5	3.78	3.95	3.81	3.76	3.72	3.68	3.64	3.60	3.55	3.51	3.47	3.43	3.39	3.34	3.30	3.26	3.22	3.18	3.13	3.09	3.05	3.01	2.97	2.92	2.88
74.0	3.82	3.99	3.84	3.80	3.76	3.71	3.67	3.63	3.59	3.55	3.50	3.46	3.42	3.38	3.34	3.29	3.25	3.21	3.17	3.13	3.08	3.04	3.00	2.96	2.92
74.5	3.85	4.02	3.87	3.83	3.79	3.75	3.71	3.66	3.62	3.58	3.54	3.50	3.45	3.41	3.37	3.33	3.29	3.24	3.20	3.16	3.12	3.08	3.03	2.99	2.95
75.0	3.89	4.06	3.91	3.87	3.82	3.78	3.74	3.70	3.66	3.61	3.57	3.53	3.49	3.45	3.40	3.36	3.32	3.28	3.24	3.19	3.15	3.11	3.07	3.03	2.98
75.5	3.92	4.09	3.94	3.90	3.86	3.82	3.77	3.73	3.69	3.65	3.61	3.56	3.52	3.48	3.44	3.40	3.35	3.31	3.27	3.23	3.19	3.14	3.10	3.06	3.02
76.0	3.95	4.12	3.98	3.94	3.89	3.85	3.81	3.77	3.73	3.68	3.64	3.60	3.56	3.52	3.47	3.43	3.39	3.35	3.31	3.26	3.22	3.18	3.14	3.10	3.05
76.5	3.99	4.16	4.01	3.97	3.93	3.89	3.84	3.80	3.76	3.72	3.68	3.63	3.59	3.55	3.51	3.47	3.42	3.38	3.34	3.30	3.26	3.21	3.17	3.13	3.09
77.0	4.02	4.19	4.05	4.00	3.96	3.92	3.88	3.84	3.79	3.75	3.71	3.67	3.63	3.58	3.54	3.50	3.46	3.42	3.37	3.33	3.29	3.25	3.21	3.16	3.12

APPENDIX D — PULMONARY FUNCTION STANDARDS FOR COTTON DUST STANDARD

The spirometric measurements of pulmonary function shall conform to the following minimum standards, and these standards are not intended to preclude additional testing or alternate methods which can be determined to be superior.

I. APPARATUS

A. The instrument shall be accurate to within ±50 milliliters or within ±3 percent of reading, whichever is greater.

B. The instrument should be capable of measuring vital capacity from 0 to 7 liters BTPS.

C. The instrument shall have a low inertia and offer low resistance to airflow such that the resistance to airflow at 12 liters per second must be less than 1.5 cm H_2O/(liter/sec).

D. The zero time point for the purpose of timing the FEV_1 shall be determined by extrapolating the steepest portion of the volume time curve back to the maximal inspiration volume (1,2,3,4) or by an equivalent method.

E. Instruments incorporating measurements of airflow to determine volume shall conform to the same volume accuracy stated in (A) of this section when presented with flow rates from at least 0 to 12 liters per second.

F. The instrument or user of the instrument must have a means of correcting volumes to body temperature saturated with water vapor (BTPS) under conditions of varying ambient spirometer temperatures and barometric pressures.

G. The instrument used shall provide a tracing or display of either flow versus volume or volume versus time during the entire forced expiration. A tracing or display is necessary to determine whether the patient has performed the test properly. The tracing must be stored and available for recall and must be of sufficient size that hand measurements may be made within requirements of paragraph (A) of this section. If a paper record is made it must have a paper speed of at least 2 cm/sec and a volume sensitivity of at least 10.0 mm of chart per liter of volume.

H. The instrument shall be capable of accumulating volume for a minimum of 10 seconds and shall not stop accumulating volume before (1) volume change for a 0.5 second interval is less than 25 milliliters or (2) the flow is less than 50 milliliters per second for a 0.5 second interval.

I. The forced vital capacity (FVC) and forced expiratory volume in 1 second ($FEV_{1.0}$) measurements shall comply with the accuracy requirements stated in paragraph (A) of this section. That is, they should be accurately measured to within ±50 ml or within ±3 percent of reading, whichever is greater.

J. The instrument must be capable of being calibrated in the field with respect to the FEV_1 and FVC. This calibration of the FEV_1 and FVC may be either directly or indirectly through volume and time base measurements. The volume calibration source should provide a volume displacement of at least 2 liters and should be accurate to within ±30 milliliters.

II. TECHNIQUE FOR MEASUREMENT OF FORCED VITAL CAPACITY MANEUVER

A. Use of a nose clip is recommended but not required. The procedures shall be explained in simple terms to the patient who shall be instructed to loosen any tight clothing and stand in front of the apparatus. The subject may sit, but care should be taken on repeat testing that the same position be used and, if possible, the same spirometer. Particular attention shall be given to insure that the chin is slightly elevated with the neck slightly extended. The patient shall be instructed to make a full inspiration from a normal breathing pattern and then blow into the apparatus, without interruption, as hard, fast, and completely as possible. At least three forced expirations shall be carried out. During the maneuvers, the patient shall be observed for compliance with instruction. The expirations shall be checked visually for reproducibility from flow-volume or volume-time tracings or displays. The following efforts shall be judged unacceptable when the patient:

1. has not reached full inspiration preceding the forced expiration,
2. has not used maximal effort during the entire forced expiration,
3. has not continued the expiration for at least 5 seconds or until an obvious plateau in the volume time curve has occurred,
4. has coughed or closed his glottis,
5. has an obstructed mouthpiece or a leak around the mouthpiece (obstruction due to tongue being placed in front of mouthpiece, false teeth falling in front of mouthpiece, etc.)

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6. has an unsatisfactory start of expiration, one characterized by excessive hesitation (or false starts), and therefore not allowing back extrapolation of time 0 (extrapolated volume on the volume time tracing must be less than 10 percent of the FVC.)
7. has an excessive variability between the three acceptable curves. The variation between the two largest FVC's and FEV_1's of the three satisfactory tracings should not exceed 10 percent or ±100 milliliters, whichever is greater.

B. Periodic and routine recalibration of the instrument or method for recording FVC and $FEV_{1.0}$ should be performed using a syringe or other volume source of at least 2 liters.

III. INTERPRETATION OF SPIROGRAM

A. The first step in evaluating a spirogram should be to determine whether or not the patient has performed the test properly or as described in II above. From the three satisfactory tracings, the forced vital capacity (FVC) and forced expiratory volume in 1 second ($FEV_{1.0}$) shall be measured and recorded. The largest observed FVC and largest observed FEV_1 shall be used in the analysis regardless of the curve(s) on which they occur.

B. The following guidelines are recommended by NIOSH for the evaluation and management of workers exposed to cotton dust. It is important to note that employees who show reductions in FEV_1/FVC ratio below .75, or drops in Monday FEV_1 of 5 percent or greater, on their initial screening exam should be re-evaluated within a month of the first exam. Those who show consistent decrease in lung function, as shown on the following table*, should be managed as recommended.

IV. QUALIFICATIONS OF PERSONNEL ADMINISTERING THE TEST

Technicians who perform pulmonary function testing should have the basic knowledge required to produce meaningful results. Training consisting of approximately 16 hours of formal instruction should cover the following areas.

A. Basic physiology of the forced vital capacity maneuver and the determinants of airflow limitation with emphasis on the relation to reproducibility of results.

B. Instrumentation requirements including calibration procedures, sources of error and their correction.

C. Performance of the testing including subject coaching, recognition of improperly performed maneuvers and corrective actions.

D. Data quality with emphasis on reproducibility.

E. Actual use of the equipment under supervised conditions.

F. Measurement of tracings and calculations of results.

[43 F.R. 27394, June 23, 1978.]

[corrected at 43 F.R. 28473, June 30, 1978, and 43 F.R. 35032, August 8, 1978.]

*(See Appendix Z-K.)

APPENDIX E — VERTICAL ELUTRIATOR EQUIVALENCY PROTOCOL

[This appendix added by 50 FR 51179, December 13, 1985]

a. *Samples to be taken* — In order to ascertain equivalency, it is necessary to collect a total of 100 samples from at least 10 sites in a mill. That is, there should be 10 replicate readings at each of 10 sites. The sites should represent dust levels which vary over the allowable range of 0.5 to 2 times the permissible exposure limit. Each sample requires the use of two vertical elutriators (VE's) and at least one but not more than two alternative devices (AD's). Thus, the end result is 200 VE readings and either 100 or 200 AD readings. The 2 VE readings and the 1 or 2 AD readings at each time and site must be made simultaneously. That is, the two VE's and one or two AD's must be arranged together in such a way that they are measuring essentially the same dust levels.

b. *Data averaging* — The two VE readings taken at each site are then averaged. These averages are to be used as the 100 VE readings. If two alternate devices were used, their test results are also averaged. Thus, after this step is accomplished, there will be 100 VE readings and 100 AD readings.

c. *Differences* — For each of the 100 sets of measurements (VE and AD) the difference is obtained as the average VE reading minus the AD reading. Call these differences D_i. Thus, we have:

$$D_i = VE_i - AD_i,\ i = 1,2,\ldots,100 \qquad (1)$$

Next we compute the arithmetic mean and standard deviations of the differences, using equations (2) and (3), respectively.

$$\overline{X_D} = \frac{1}{N} \sum_{i=1}^{N} D_i \qquad (2)$$

$$S_D = \sqrt{\frac{\sum D_i^2 - \frac{(\sum D_i)^2}{N}}{N-1}} \qquad (3)$$

Where N equals the number of differences (100 in this case), $\overline{X}_D$ is the arithmetic mean and S_D is the standard deviation.

We next calculate the critical value as $T = KS_D + |\overline{X}_D|$ where $K = 1.87$, based on 100 samples.

d. *Equivalency test.* The next step is to obtain the average of the 100 VE readings. This is obtained by equation (4).

$$X_{VE} = \frac{1}{N}\left(\sum_{i=1}^{N} VE_i\right) \qquad (4)$$

We next multiply 0.25 by $\overline{X}_{VE}$. If $T < 0.25\,\overline{X}_{VE}$, we can say that the alternate device has passed the equivalency test.

(The information collection requirements contained in the section are under consideration by the Office of Management and Budget. They will not take effect until approved.)

APPENDIX A — SUBSTANCE SAFETY DATA SHEET FOR DBCP

I. SUBSTANCE IDENTIFICATION

A. **Synonyms and Trade Names**

DBCP; Dibromochloropropane; Fumazone (Dow Chemical Company TM); Nemafume; Nemagon (Shell Chemical Co. TM); Nemaset; BBC 12; and OS 1879.

B. **Permissible Exposure**

1. **Airborne**

One part DBCP vapor per billion parts of air (1 ppb); time-weighted average (TWA) for an 8-hour workday.

2. **Dermal**

Eye contact and skin contact with DBCP are prohibited.

C. **Appearance and Odor**

Technical grade DBCP is a dense yellow or amber liquid with a pungent odor. It may also appear in granular form, or blended in varying concentrations with other liquids.

D. **Uses**

DBCP is used to control nematodes, very small worm-like plant parasites, on crops including cotton, soybeans, fruits, nuts, vegetables and ornamentals.

II. HEALTH HAZARD DATA

A. **Routes of Entry**

Employees may be exposed:

1. Through inhalation (breathing);
2. Through ingestion (swallowing);
3. Skin contact; and
4. Eye contact.

B. **Effects of Exposure**

1. **Acute exposure**

DBCP may cause drowsiness, irritation of the eyes, nose, throat and skin, nausea and vomiting. In addition, overexposure may cause damage to the lungs, liver or kidneys.

2. **Chronic exposure**

Prolonged or repeated exposure to DBCP has been shown to cause sterility in humans. It also has been shown to produce cancer and sterility in laboratory animals and has been determined to constitute an increased risk of cancer in man.

3. **Reporting signs and symptoms**

If you develop any of the above signs or symptoms that you think are caused by exposure to DBCP, you should inform your employer.

III. EMERGENCY FIRST AID PROCEDURES

A. **Eye Exposure**

If DBCP liquid or dust containing DBCP gets into your eyes, wash your eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention immediately. Contact lenses should not be worn when working with DBCP.

B. **Skin Exposure**

If DBCP liquids or dusts containing DBCP get on your skin, immediately wash using soap or mild detergent and water. If DBCP liquids or dusts containing DBCP penetrate through your clothing, remove the clothing immediately and wash. If irritation is present after washing get medical attention.

C. **Breathing**

If you or any person breathe in large amounts of DBCP, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Do not use mouth-to-mouth. Keep the affected person warm and at rest. Get medical attention as soon as possible.

D. **Swallowing**

When DBCP has been swallowed and the person is conscious, give the person large amounts of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. Get medical attention immediately.

E. **Rescue**

Notify someone. Put into effect the established emergency rescue procedures. Know the locations of the emergency rescue equipment before the need arises.

IV. RESPIRATORS AND PROTECTIVE CLOTHING

A. **Respirators**

You may be required to wear a respirator in emergencies and while your employer is in the process of reducing DBCP exposures through engineering con-

trols. If respirators are worn, they must have a National Institute for Occupational Safety and Health (NIOSH) approval label (older respirators may have a Bureau of Mines Approval label). For effective protection, a respirator must fit your face and head snugly. The respirator should not be loosened or removed in work situations where its use is required. DBCP does not have a detectable odor except at 1,000 times or more above the permissible exposure limit. If you can smell DBCP while wearing a respirator, the respirator is not working correctly; go immediately to fresh air. If you experience difficulty breathing while wearing a respirator, tell your employer.

B. **Protective Clothing**

When working with DBCP you must wear for your protection impermeable work clothing provided by your employer. (Standard rubber and neoprene protective clothing do not offer adequate protection).

DBCP must never be allowed to remain on the skin. Clothing and shoes must not be allowed to become contaminated with DBCP, and if they do, they must be promptly removed and not worn again until completely free of DBCP. Turn in impermeable clothing that has developed leaks for repair or replacement.

C. **Eye Protection**

You must wear splash-proof safety goggles where there is any possibility of DBCP liquid or dust contacting your eyes.

V. PRECAUTIONS FOR SAFE USE, HANDLING AND STORAGE

A. DBCP must be stored in tightly closed containers in a cool, well-ventilated area.

B. If your work clothing may have become contaminated with DBCP, or liquids or dusts containing DBCP, you must change into uncontaminated clothing before leaving the work premises.

C. You must promptly remove any protective clothing that becomes contaminated with DBCP. This clothing must not be reworn until the DBCP is removed from the clothing.

D. If your skin becomes contaminated with DBCP, you must immediately and thoroughly wash or shower with soap or mild detergent and water to remove any DBCP from your skin.

E. You must not keep food, beverages, cosmetics, or smoking materials, nor eat or smoke, in regulated areas.

F. If you work in a regulated area, you must wash your hands thoroughly with soap or mild detergent and water, before eating, smoking or using toilet facilities.

G. If you work in a regulated area, you must remove any protective equipment or clothing before leaving the regulated area.

H. Ask your supervisor where DBCP is used in your work area and for any additional safety and health rules.

VI. ACCESS TO INFORMATION

A. Each year, your employer is required to inform you of the information contained in this Substance Safety Data Sheet for DBCP. In addition, your employer must instruct you in the safe use of DBCP, emergency procedures, and the correct use of protective equipment.

B. Your employer is required to determine whether you are being exposed to DBCP. You or your representative have the right to observe employee exposure measurements and to record the result obtained. Your employer is required to inform you of your exposure. If your employer determines that you are being overexposed, he is required to inform you of the actions which are being taken to reduce your exposure.

C. Your employer is required to keep records of your exposure and medical examinations. Your employer is required to keep exposure and medical data for at least 40 years or the duration of your employment plus 20 years, whichever is longer.

D. Your employer is required to release exposure and medical records to you, your physician, or other individual designated by you upon your written request.

APPENDIX B — SUBSTANCE TECHNICAL GUIDELINES FOR DBCP

I. PHYSICAL AND CHEMICAL DATA

A. **Substance Identification**

1. **Synonyms**

   1,2-dibromo-3-chloropropane; DBCP; Fumazone; Nemafume; Nemagon; Nemaset, BBC 12, OS 1879. DBCP is also included in agricultural pesticides and fumigants which include the phrase "Nema———" in their name.

2. **Formula:** C3H5Br2Cl.
3. **Molecular weight:** 236.

B. **Physical Data**

1. **Boiling point:** (760 mm HG): 195C (383F)
2. **Specific gravity:** (water=1): 2.093.
3. **Vapor density:** (air=1 at boiling point of DBCP): Data not available.
4. **Melting point:** 6C (43F).
5. **Vapor pressure at 20C:** (68F): 0.8 mm Hg
6. **Solubility in water:** 1000 ppm.
7. **Evaporation rate:** (Butyl Acetate = 1): very much less than 1.
8. **Appearance and odor:** Dense yellow or amber liquid with a pungent odor at high concentrations. Any detectable odor of DBCP indicates overexposure.

II. FIRE EXPLOSION AND REACTIVITY HAZARD DATA

A. **Fire**

1. **Flash point:** 170F (77C)
2. **Autoignition temperature:** Data not available.
3. **Flammable limits in air, percent by volume:** Data not available.
4. **Extinguishing media:** Carbon dioxide, dry chemical.
5. **Special fire-fighting procedures:** Do not use a solid stream of water since a stream will scatter and spread the fire. Use water spray to cool containers exposed to a fire.
6. **Unusual fire and explosion hazards:** None known.
7. For purposes of complying with the requirements of 1910.106, liquid DBCP is classified as a **Class III A combustible liquid.**
8. For the purpose of complying with 1910.309, the classification of hazardous locations as described in article 500 of the National Electrical Code for DBCP shall be **Class I, Group D.**
9. For the purpose of compliance with 1910.157, DBCP is classified as a **Class B fire hazard.**
10. For the purpose of compliance with 1910.178, locations classified as hazardous locations due to the presence of DBCP shall be **Class I, Group D.**
11. Sources of ignition are prohibited where DBCP presents a fire or explosion hazard.

B. **Reactivity**

1. **Conditions contributing to instability:** None known.
2. **Incompatibilities:** Reacts with chemically active metals, such as aluminum, magnesium and tin alloys.
3. **Hazardous decomposition products:** Toxic gases and vapors (such as HBr, HCl and carbon monoxide) may be released in a fire involving DBCP.
4. **Special precautions:** DBCP will attack some rubber materials and coatings.

III. SPILL, LEAK AND DISPOSAL PROCEDURES

A. If DBCP is spilled or leaked, the following steps should be taken:

1. The area should be evacuated at once and reentered only after thorough ventilation.
2. Ventilate area of spill or leak.
3. If in liquid form, collect for reclamation or absorb in paper, vermiculite, dry sand, earth or similar material.
4. If in solid form, collect spilled material in the most convenient and safe manner for reclamation or for disposal.

B. Persons not wearing protective equipment must be restricted from areas of spills or leaks until cleanup has been completed.

C. **Waste Disposal Methods**

1. For small quantities of **liquid DBCP**, absorb on paper towels, remove to a safe place (such as a fume hood) and burn the paper. Large quantities can be reclaimed or collected and atomized in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device. If liquid DBCP is absorbed in vermiculite, dry sand, earth or similar material and placed in sealed containers, it may be disposed of in a State-approved sanitary landfill.

2. If in **solid form**, for small quantities, place on paper towels, remove to a safe place (such as a fume hood) and burn. Large quantities may be reclaimed. However, if this is not practical, dissolve in a flammable solvent (such as alcohol) and atomize in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device. DBCP in solid form may also be disposed in a State-approved sanitary landfill.

IV. MONITORING AND MEASUREMENT PROCEDURES

A. **Exposure Above the Permissible Exposure Limit.**

1. **Eight hour exposure evaluation:**

   Measurements taken for the purpose of determining employee exposure under this section are best taken so that the average 8-hour exposure may be determined from a single 8-hour sample or two (2) 4-hour samples. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee.)

2. **Monitoring techniques:**

   The sample and analysis under this section may be performed by collecting the DBCP vapor on petroleum based charcoal absorption tubes with subsequent chemical analyses. The method of measurement chosen should determine the concentration of airborne DBCP at the permissible exposure limit to an accuracy of plus or minus 25 percent. If charcoal tubes are used, a total volume of 10 liters should be collected at a flow rate of 50 cc. per minute for each tube. Analyze the resultant samples as you would samples of halogenated solvent.

B. Since many of the duties relating to employee protection are dependent on the results of monitoring and measuring procedures, employers should assure that the evaluation of employee exposures is performed by a competent industrial hygienist or other technically qualified person.

V. PROTECTIVE CLOTHING

Employees should be required to wear appropriate protective clothing to prevent any possibility of skin contact with DBCP. Because DBCP is absorbed through the skin, it is important to prevent skin contact with both liquid and solid forms of DBCP. Protective clothing should include impermeable coveralls or similar fullbody work clothing, gloves, headcoverings, and workshoes or shoe coverings. Standard rubber and neoprene gloves do not offer adequate protection and should not be relied upon to keep DBCP off the skin. DBCP should never be allowed to remain on the skin. Clothing and shoes should not be allowed to become contaminated with the material, and if they do, they should be promptly removed and not worn again until completely free of the material. Any protective clothing which has developed leaks or is otherwise found to be defective should be repaired or replaced. Employees should also be required to wear splash-proof safety goggles where there is any possibility of DBCP contacting the eyes.

VI. HOUSEKEEPING AND HYGIENE FACILITIES

1. The workplace must be kept clean, orderly and in a sanitary condition;
2. Dry sweeping and the use of compressed air is unsafe for the cleaning of floors and other surfaces where DBCP dust or liquids are found. To minimize the contamination of air with dust, vacuuming with either portable or permanent systems must be used. If a portable unit is selected, the exhaust must be attached to the general workplace exhaust ventilation system, or collected within the vacuum unit equipped with high efficiency filters or other appropriate means of contamination removal and not used for other purposes. Units used to collect DBCP must be labeled.
3. Adequate washing facilities with hot and cold water must be provided, and maintained in a sanitary condition. Suitable cleansing agents should also be provided to assure the effective removal of DBCP from the skin.
4. Change or dressing rooms with individual clothes storage facilities must be provided to prevent the contamination of street clothes with DBCP. Because of the hazardous nature of DBCP, contaminated protective clothing must be stored in closed containers for cleaning or disposal.

VII. MISCELLANEOUS PRECAUTIONS

A. Store DBCP in tightly closed containers in a cool, well ventilated area.

B. Use of supplied-air suits or other impervious clothing (such as acid suits) may be necessary to prevent skin contact with DBCP. Supplied-air suits should be selected, used, and maintained under the supervision of person knowlegeable in the limitations and potential life-endangering characteristics of supplied-air suits.

C. The use of air-conditioned suits may be necessary in warmer climates.

D. Advise employees of all areas and operations where exposure to DBCP could occur.

VIII. COMMON OPERATIONS

Common operations in which exposure to DBCP is likely to occur are: during its production; and during its formulation into pesticides and fumigants.

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APPENDIX C — MEDICAL SURVEILLANCE GUIDELINES FOR DBCP

I. ROUTE OF ENTRY

Inhalation; skin absorption.

II. TOXICOLOGY

Recent data collected on workers involved in the manufacture and formulation of DBCP has shown that DBCP can cause sterility at very low levels of exposure. This finding is supported by studies showing that DBCP causes sterility in animals. Chronic exposure to DBCP resulted in pronounced necrotic action on the parenchymatous organs (i.e., liver, kidney, spleen) and on the testicles of rats at concentrations as low as 5 ppm. Rats that were chronically exposed to DBCP also showed changes in the composition of the blood, showing low RBC, hemoglobin, and WBC, and high reticulocyte levels as well as functional hepatic disturbance, manifesting itself in a long prothrombin time. Reznik et al. noted a single dose of 100 mg produced profound depression of the nervous system of rats. Their condition gradually improved. Acute exposure also resulted in the destruction of the sex gland activity of male rats as well as causing changes in the estrous cycle in female rats. Animal studies have also associated DBCP with an increased incidence of carcinoma. Olson et al. orally administered DBCP to rats and mice 5 times per week at experimentally predetermined maximally tolerated doses and at half those doses. As early as ten weeks after initiation of treatment, DBCP induced a high incidence of squamous cell carcinomas of the stomach with metastases in both species. DBCP also induced mammary adenocarcinomas in the female rats at both dose levels.

III. SIGNS AND SYMPTOMS

A. **Inhalation:**

Nausea, eye irritation, conjunctivitis, respiratory irritation, pulmonary congestion or edema, CNS depression with apathy, sluggishness, and ataxia.

B. **Dermal:**

Erythema or inflammation and dermatitis on repeated exposure.

IV. SPECIAL TESTS

A. **Semen Analysis:**

The following information excerpted from the document "Evaluation of Testicular Function," submitted by the Corporate Medical Department of the Shell Oil Company (exhibit 39-3), may be useful to physicians conducting the medical surveillance program:

In performing semen analyses certain minimal but specific criteria should be met:

1. It is recommended that a minimum of three valid semen analyses be obtained in order to make a determination of an individual's average sperm count.

2. A period of sexual abstinence is necessary prior to the collection of each masturbatory sample. It is recommended that intercourse or masturbation be performed 48 hours before the actual specimen collection. A period of 48 hours of abstinence would follow; then the masturbatory sample would be collected.

3. Each semen specimen should be collected in a clean, widemouthed, glass jar (not necessarily pre-sterilized) in a manner designated by the examining physician. Any part of the seminal fluid exam should be initialed *only after liquifaction* is complete, i.e., 30 to 45 minutes after collection.

4. Semen volume should be measured to the nearest 1/10 of a cubic centimeter.

5. Sperm density should be determined using routine techniques involving the use of a white cell pipette and a hemocytometer chamber. The immobilizing fluid most effective and most easily obtained for this process is distilled water.

6. Thin, dry smears of the semen should be made for a morphologic classification of the sperm forms and should be stained with either hematoxalin or the more difficult, yet more precise, Papanicolaou technique. Also of importance to record is obvious sperm agglutination, pyospermia, delayed liquifaction (greater than 30 minutes), and hyperviscosity. In addition, pH, using nitrazine paper, should be determined.

7. A total morphology evaluation should include percentages of the following:
   a. Normal (oval) forms,
   b. Tapered forms,
   c. Amorphous forms (include large and small sperm shapes),
   d. Duplicated (either heads or tails) forms, and
   e. Immature forms.

8. Each sample should be evaluated for sperm *viability* (percent viable sperm moving at the time of examination) as well as sperm *motility* (subjective characterization of "purposeful forward sperm progression" of the majority of those viable sperm analyzed) within two hours after collection, ideally by the same or equally qualified examiner.

B. **Serum Determinations**

The following serum determinations should be performed by radioimmuno-assay techniques using National Institutes of Health (NIH) specific antigen or antigen preparations of equivalent sensitivity:

1. Serum follicle stimulating hormone (FSH);
2. Serum luteinizing hormone (LH); and
3. Serum total estrogen (females only).

V. TREATMENT

Remove from exposure immediately, give oxygen or artificial resuscitation if indicated. Contaminated clothing and shoes should be removed immediately. Flush eyes and wash contaminated skin. If swallowed and the person is conscious, induce vomiting. Recovery from mild exposures is usally rapid and complete.

VI. SURVEILLANCE AND PREVENTIVE CONSIDERATIONS

A. **Other Considerations**

DBCP can cause both acute and chronic effects. It is important that the physician become familiar with the operating conditions in which exposure to DBCP occurs. Those with respiratory disorders may not tolerate the wearing of negative pressure respirators.

B. **Surveillance and Screening**

Medical histories and laboratory examinations are required for each employee subject to exposure to DBCP. The employer should screen employees for history of certain medical conditions (listed below) which might place the employee at increased risk from exposure.

1. **Liver disease**

The primary site of biotransformation and detoxification of DBCP is the liver. Liver dysfunctions likely to inhibit the conjugation reactions will tend to promote the toxic actions of DBCP. These precautions should be considered before exposing persons with impaired liver funcion to DBCP.

2. **Renal disease**

Because DBCP has been associated with injury to the kidney it is important that special consideration be given to those with possible impairment of renal function.

3. **Skin disease**

DBCP can penetrate the skin and can cause erythema on prolonged exposure. Persons with pre-existing skin disorders may be more susceptible to the effects of DBCP.

4. **Blood dyscrasias**

DBCP has been shown to decrease the content of erythrocytes, hemoglobin, and leukocytes in the blood, as well as increase the prothrombin time. Persons with existing blood disorders may be more susceptible to the effects of DBCP.

5. **Reproductive disorders**

Animal studies have associated DBCP with various effects on the reproductive organs. Among these effects are atrophy of the testicles and changes in the estrous cycle. Persons with pre-existing reproductive disorders may be at increased risk to these effects of DBCP.

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(Secs. 6, 8, 84 Stat. 1593, 1596, 1599, (29 U.S.C. 655, 657); Secretary of Labor's Order 8-76 (41 FR 25059); (29 CFR 1911)

[Sec. 1910.1044 added at 43 FR 11527, March 17, 1978]

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APPENDIX A—SUBSTANCE SAFETY DATA SHEET

I. SUBSTANCE IDENTIFICATION

A. Substance: Acrylonitrile ($CH_2=CHCN$).

B. Synonyms: Propenenitrile; vinyl cyanide; cyanoethylene; AN; VCN; acrylon; carbacryl; fumigrain; ventox.

C. Acrylonitrile can be found as a liquid or vapor, and can also be found in polymer resins, rubbers, plastics, polyols, and other polymers having acrylonitrile as a raw or intermediate material.

D. AN is used in the manufacture of acrylic and modiacrylic fibers, acrylic plastics and resins, speciality polymers, nitrile rubbers, and other organic chemicals. It has also been used as a fumigant.

E. Appearance and odor: Colorless to pale yellow liquid with a pungent order which can only be detected at concentrations above the permissible exposure level, in a range of 13–19 parts AN per million parts of air (13–19 ppm).

F. Permissible exposure: Exposure may not exceed either;

1. Two parts AN per million parts of air (2 ppm) averaged over the 8-hour workday; or

2. Ten parts AN per million parts of air (10 ppm) averaged over any 15-minute period in the workday.

3. In addition, skin and eye contact with liquid AN is prohibited.

II. HEALTH HAZARD DATA

A. Acrylonitrile can affect your body if you inhale the vapor (breathing), if it comes in contact with your eyes or skin, or if you swallow it. It may enter your body through your skin.

B. Effects of overexposure: 1. Short-term exposure: acrylonitrile can cause eye irritation, nausea, vomiting, headache, sneezing, weakness, and light-headedness. At high concentrations, the effects of exposure may go on to loss of consciousness and death. When acrylonitrile is held in contact with the skin after being absorbed into shoe leather or clothing, it may produce blisters following several hours of no apparent effect. Unless the shoes or clothing are removed immediately and the area washed, blistering will occur. Usually there is no pain or inflammation associated with blister formation.

2. Long-term exposure: Acrylonitrile has been shown to cause cancer in laboratory animals and has been associated with higher incidences of cancer in humans. Repeated or prolonged exposure of the skin to acrylonitrile may produce irritation and dermatitis.

3. Reporting signs and symptoms: You should inform your employer if you develop any signs or symptoms and suspect they are caused by exposure to acrylonitrile.

III. EMERGENCY FIRST AID PROCEDURES

A. Eye exposure: If acrylonitrile gets into your eyes, wash your eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention immediately. Contact lenses should not be worn when working with this chemical.

B. Skin exposure: If acrylonitrile gets on your skin, immediately wash the contaminated skin with water. If acrylonitrile soaks through your clothing, especially your shoes, remove the clothing immediately and wash the skin with water. If symptoms occur after washing, get medical attention immediately. Thoroughly wash the clothing before reusing. Contaminated leather shoes or other leather articles should be discarded.

C. Inhalation: If you or any other person breathes in large amounts of acrylonitrile, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

D. Swallowing: When acrylonitrile has been swallowed, give the person large quantities of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. Get medical attention immediately.

E. Rescue: Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency procedures. Do not become a casualty yourself. Understand your emergency rescue procedures and know the location of the emergency equipment before the need arises.

F. Special first aid procedures: First aid kits containing an adequate supply (at least two dozen) of amyl nitrite pearls, each containing 0.2 ml, should be maintained at each site where acrylonitrile is used. When a person is suspected of receiving an overexposure to acrylonitrile, immediately remove that person from the contaminated area using established rescue procedures. Contaminated clothing must be removed and the acrylonitrile washed from the skin immediately. Artificial respiration should be started at once if breathing has stopped. If the person is unconscious, amyl nitrite may be used as an antidote by a properly trained individual in accordance with established emergency procedures. Medical aid should be obtained immediately.

IV. RESPIRATORS AND PROTECTIVE CLOTHING

a. Respirators: You may be required to wear a respirator for nonroutine activities, in emergencies, while your employer is in the process of reducing acrylonitrile exposures through engineering controls, and in areas where engineering controls are not feasible. If respirators are worn, they must have a Mine Safety and Health Administration (MSHA or MESA) or National Institute for Occupational Safety and Health (NIOSH) label of approval for use with organic vapors. (Older respirators may have a Bureau of Mines approved label.) For effective protection, respirators must fit your face and head snugly. Respirators should not be loosened or removed in work situations where their use is required.

Acrylonitrile does not have a detectable odor except at levels above the permissible exposure limits. Do not depend on odor to warn you when a respirator cartridge or canister is exhausted. Cartridges or canisters must be changed daily or before the end-of-service life, whichever comes first. Reuse of these may allow acrylonitrile to gradually filter through the cartridge and cause exposures which you cannot detect by odor. If you can smell acrylonitrile while wearing a respirator, proceed immediately to fresh air. If you experience difficulty breathing while wearing a respirator, tell your employer.

B. Supplied-air suits: In some work situations, the wearing of supplied-air suits may be necessary. Your employer must instruct you in their proper use and operation.

C. Protective clothing: You must wear impervious clothing, gloves, face shield, or other appropriate protective clothing to prevent skin contact with liquid acrylonitrile. Where protective clothing is required, your employer is required to provide clean garments to you as necessary to assume that the clothing protects you adequately.

Replace or repair impervious clothing that has developed leaks.

Acrylonitrile should never be allowed to remain on the skin. Clothing and shoes which are not impervious to acrylonitrile should not be allowed to become contaminated with acrylonitrile, and if they do the clothing and shoes should be promptly removed and decontaminated. The clothing should be laundered or discarded after the AN is removed. Once acrylonitrile penetrates shoes or other leather articles, they should not be worn again.

D. Eye protection: You must wear splashproof safety goggles in areas where liquid acrylonitrile may contact your eyes. In addition, contact lenses should not be worn in areas were eye contact with acrylonitrile can occur.

V. PRECAUTIONS FOR SAFE USE, HANDLING, AND STORAGE

A. Acrylonitrile is a flammable liquid, and its vapors can easily form explosive mixtures in air.

B. Acrylonitrile must be stored in tightly closed containers in a cool, well-ventilated area, away from heat, sparks, flames, strong oxidizers (especially bromine), strong bases, copper, copper alloys, ammonia, and amines.

C. Sources of ignition such as smoking and open flames are prohibited whereever acrylonitrile is handled, used, or stored in a manner that could create a potential fire or explosion hazard.

D. You should use non-sparking tools when opening or closing metal containers of acrylonitrile, and containers must be bonded and grounded when pouring or transferring liquid acrylonitrile.

E. You must immediately remove any nonimpervious clothing that becomes wetted with acrylonitrile, and this clothing must not be reworn until the acrylonitrile is removed from the clothing.

F. Impervious clothing wet with liquid acrylonitrile can be easily ignited. This clothing must be washed down with water before you remove it.

G. If your skin becomes wet with liquid acrylonitrile, you must promptly and thoroughly wash or shower with soap or mild detergent to remove any acrylonitrile from your skin.

H. You must not keep food, beverages, or smoking materials, nor are you permitted to eat or smoke in regulated areas where acrylonitrile concentrations are above the permissible exposure limits.

I. If you contact liquid acrylonitrile, you must wash your hands thoroughly with soap or mild detergent and water before eating, smoking, or using toilet facilities.

J. Fire extinguishers and quick drenching facilities must be readily available, and you should know where they are and how to operate them.

K. Ask your supervisor where acrylonitrile is used in your work area and for any additional plant safety and health rules.

VI. ACCESS TO INFORMATION

A. Each year, your employer is required to inform you of the information contained in this Substance Safety Data Sheet for acrylonitrile. In addition, your employer must instruct you in the proper work practices for using acrylonitrile, emergency procedures, and the correct use of protective equipment.

B. Your employer is required to determine whether you are being exposed to acrylonitrile. You or your representative has the right to observe employee measurements and to record the results obtained. Your employer is required to inform you of your exposure. If your employer determines that you are being overexposed, he or she is required to inform you of the actions which are being taken to reduce your exposure to within permissible exposure limits.

C. Your employer is required to keep records of your exposures and medical examinations. These records must be kept by the employer for at least forty (40) years or for the period of your employment plus twenty (20) years, whichever is longer.

D. Your employer is required to release your exposure and medical records to your physician upon your written request.

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APPENDIX B–SUBSTANCE TECHNICAL GUIDELINES FOR ACRYLONITRILE

I. PHYSICAL AND CHEMICAL DATA

Substance identification: 1. Synonyms: AN; VCN; vinyl cyanide; propenenitrile; cyanoethylene; Acrylon; Carbacryl; Fumigrain; Ventox.

2. Formula: CH2=CHCN.

3. Molecular weight: 53.1

B. Physical data: 1. Boiling point (760 mm Hg): 77.3°C (171°F);

2. Specific gravity (water=1): 0.81 (at 20°C or 68°F);

3. Vapor density (air=1 at boiling point of acrylonitrile): 1.83;

4. Melting point: −83°C (−117°F);

5. Vapor pressure (@20° F): 83 mmm HG;

6. Solubility in water, percent by weight @20° C (68° F): 7.35;

7. Evaporation rate (Butyl Acetate=1): 4.54; and

8. Appearance and odor: Colorless to pale yellow liquid with a pungent ordor at concentrations above the permissible exposure level. Any detectable odor of acrylonitrile may indicate overexposure.

II. FIRE, EXPLOSION, AND REACTIVITY HAZARD

A. Fire: 1. Flash point: −1° C (30° F) (closed cup).

2. Autoignition temperature: 481° C 898° F).

3. Flammable limits air, percent by volume: Lower: 3, Upper: 17.

4. Extinguishing media: Alcohol foam, carbon dioxide, and dry chemical.

5. Special fire-fighting procedures: Do not use a solid stream of water, since the stream will scatter and spread the fire. Use water to cool containers exposed to a fire.

6. Unusual fire and explosion hazards: Acrylonitrile is a flammable liquid. Its vapors can easily form explosive mixtures with air. All ignition sources must be controlled where acrylonitrile is handled, used, or stored in a manner that could create a potential fire or explosion hazard. Acrylonitrile vapors are heavier than air and may travel along the ground and be ignited by open flames or sparks at locations remote from the site at which acrylonitrile is being handled.

7. For purposes of compliance with the requirements of 29 CFR 1910.106, acrylonitrile is classified as a class IB flammable liquid. For example, 7,500 ppm, approximately one-fourth of the lower flammable limit, would be considered to pose a potential fire and explosion hazard.

8. For purposes of compliance with 29 CFR 1910.157, acrylonitrile is classified as a Class B fire hazard.

9. For purpose of compliance with 29 CFR 1919.309, locations classified as hazardous due to the presence of acrylonitrile shall be Class I, Group D.

B. Reactivity:

1. Conditions contributing to instability: Acrylonitrile will polymerize when hot, and the additional heat liberated by the polymerization may cause containers to explode. Pure AN may self-polymerize, with a rapid build-up pressure, resulting in an explosion hazard. Inhibitors are added to the commercial product to prevent self-polymerization.

2. Incompatibilities: Contact with strong oxidizers (especially bromine) and strong bases may cause fires and explosions. Contact with cooper, cooper alloys, ammonia, and amines may start serious decomposition.

3. Hazardous decomposition products: Toxic gases and vapors (such as hydrogen cyanide, oxides of nitrogen, and carbon monoxide) may be released in a fire involving acrylonitrile and certain polymers made from acrylonitrile.

4. Special precautions: Liquid acrylonitrile will attack some forms of plastics, rubbers, and coatings.

III. SPILL, LEAK, AND DISPOSAL PROCEDURES

A. If acrylonitrile is spilled or leaked, the following steps should be taken:

1. Remove all ignition sources.

2. The area should be evacuated at once and re-entered only after the area has been thoroughly ventilated and washed down with water.

3. If liquid acrylonitrile or polymer intermediate, collect for reclamation or absorb in paper, vermiculite, dry sand, earth, or similar material, or wash down with water into process sewer system.

B. Persons not wearing protective equipment should be restricted from areas of spills or leaks until clean-up has been completed.

C. Waste disposal methods: Waste material shall be disposed of in a manner that is not hazardous to employees or to the general population. Spills of acrylonitrile and flushing of such spills shall be channeled for appropriate treatment or collection for disposal. They shall not be channeled directly into the sanitary sewer system. In selecting the method of waste disposal, applicable local, State, and Federal regulations should be consulted.

IV. MONOTORING AND MEASUREMENT PROCEDURES

A. Exposure above the Permissible Exposure Limit:

1. Eight-hour exposure evaluation: Measurements taken for the purpose of determining employee exposure under this section are best taken so that average 8-hour exposure may be determined from a single 8-hour sample or two (2) 4-hour samples. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee.)

2. Ceiling evaluation: Measurements taken for the purpose of determining employee exposure under this section must be taken during periods of maximum expected airborne concentrations of acrylonitrile in the employee's breathing zone. A minimum of three (3) measurements should be taken on one work shift. The average of all measurements taken is an estimate of the employee's ceiling exposure.

3. Monitoring techniques: The sampling and analysis under this section may be performed by collecting the acrylonitrile vapor on charcoal adsorption tubes or other composition adsorption tubes, with subsequent chemical analysis. Sampling and analysis may also be performed by instruments such as real-time continuous monotoring systems, portable direct-reading instruments, or passive dosimeters. Analysis of resultant samples should be by gas chromatograph.

Appendix D lists methods of sampling and analysis which have been tested by NIOSH and OSHA for use with acrylonitrile. NIOSH and OSHA have validated modifications of NIOSH Method S-156 (See Appendix D) under laboratory conditions for concentrations below 1 ppm. The employer has the obligation of selecting a monitoring method which meets the accuracy and precision requirements of the standard under his unique field conditions. The standard requires that methods of monitoring must be accurate, to a 95-percent confidence level, to ±35-percent for concentrations of AN at or above 2 ppm, and to ±50-percent for concentrations below 2 ppm. In addition to the methods described in Appendix D., there are numerous other methods available for monitoring for AN in the workplace. Details on these other methods have been submitted by various companies to the rulemaking record, and are available at the OSHA Docket Office.

B. Since many of the duties relating to employee exposure are dependent on the results of monitoring and measuring procedures, employers shall assure that the evaluation of employee exposures is performed by a competent industrial hygienist or other technically qualified person.

V. PROTECTIVE CLOTHING

Employees shall be provided with and required to wear appropriate protective clothing to prevent any possibility of skin contact with liquid AN. Because acrylonitrile is absorbed through the skin, it is important to prevent skin contact with liquid AN. Protective clothing shall include impermeable coveralls or similar full-body work clothing, gloves, head-coverings, as appropriate to protect areas of the body which may come in contact with liquid AN.

Employers should ascertain that the protective garments are impermeable to acrylonitrile. Non-impermeable clothing and shoes should not be allowed to become contaminated with liquid AN. If permeable clothing does become contaminated, it should be promptly removed, placed in a regulated area for removal of the AN, and not worn again until the AN is removed. If leather footwear or other leather garments become wet from acrylonitrile, they should be replaced and not worn again, due to the ability of leather to absorb acrylonitrile and hold it against the skin. Since there is no pain associated with the blistering which may result from skin contact with liquid AN, it is essential that the employee be informed of this hazard so that he or she can be protected.

Any protective clothing which has developed leaks or is otherwise found to be defective shall be repaired or replaced. Clean protective clothing shall be provided to the employee as necessary to assure its protectiveness. Whenever impervious clothing becomes wet with liquid AN, it shall be washed down with water before being removed by the employee. Employees are also required to wear splash-proof safety goggles where there is any possibility of acrylonitrile contacting the eyes.

VI. HOUSEKEEPING AND HYGIENE FACILITIES

For purposes of complying with 29 CFR 1910.141, the following items should be emphasized:

A. The workplace should be kept clean, orderly, and in a sanitary condition. The employer is required to institute a leak and spill detection program for operations involving liquid AN in order to detect sources of fugitive AN emissions.

B. Dry sweeping and the use of compressed air is unsafe for the cleaning of floors and other surfaces where liquid AN may be found.

C. Adequate washing facilities with hot and cold water are to be provided, and maintained in a sanitary condition. Suitable cleansing agents are also to be provided to assure the effective removal of acrylonitrile from the skin.

D. Change or dressing rooms with individual clothes storage facilities must be provided to prevent the contamination of street clothes with acrylonitrile. Because of the hazardous nature of acrylonitrile, contaminated protective clothing should be placed in a regulated area designated by the employer for removal of the AN before the clothing is laundered or disposed of.

VII. MISCELLANEOUS PRECAUTIONS

A. Store acrylonitrile in tightly-closed containers in a cool, well-ventilated area and take necessary precautions to avoid any explosion hazard.

B. High exposures to acrylonitrile can occur when transferring the liquid from one container to another.

C. Non-sparking tools must be used to open and close metal acrylonitrile containers. These containers must be effectively grounded and bonded prior to pouring.

D. Never store uninhibited acrylonitrile.

E. Acrylonitrile vapors are not inhibited. They may form polymers and clog vents of storage tanks.

F. Use of supplied-air suits or other impervious coverings may be necessary to prevent skin contact with and provide respiratory protection from acrylonitrile where the concentration of acrylonitrile is unknown or is above the ceiling limit. Supplied-air suits should be selected, used, and maintained under the immediate supervision of persons knowledgeable in the limitations and potential life-endangering characteristics of supplied-air suits.

G. Employers shall advise employees of all areas and operations where exposure to acrylonitrile could occur.

VIII. COMMON OPERATIONS

Common operations in which exposure to acrylonitrile is likely to occur include the following: Manufacture of the acrylonitrile monomer; synthesis of acrylic fibers, ABS, SAN, and nitrile barrier plastics and resins, nitrile rubber, surface coatings, specialty chemicals, use as a chemical intermediate, use as a fumigant and in the cyanoethylation of cotton.

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APPENDIX C – MEDICAL SURVEILLANCE GUIDELINES

I. ROUTE OF ENTRY

Inhalation: skin absorption; ingestion.

II. TOXICOLOGY

Acrylonitrile vapor is an asphyxiant due to inhibitory action on metabolic enzyme systems. Animals exposed to 75 or 100 ppm for 7 hours have shown signs of anoxia; in some animals which died at the higher level, cyanomethemoglobin was found in the blood. Two human fatalities from accidental poisoning have been reported; one was caused by inhalation of an unknown concentration of the vapor, and the other was thought to be caused by skin absorption or inhalation. Most cases of intoxication from industrial exposure have been mild, with rapid onset of eye irritation, headache, sneezing, and nausea. Weakness, lightheadedness, and vomiting may also occur. Exposure to high concentrations may produce profound weakness, asphyxia, and death. The vapor is a severe eye irritant. Prolonged skin contract with the liquid may result in absorption with systemic effects, and in the formation of large blisters after a latent period of several hours. Although there is usually little or no pain or inflammation, the affected skin ressembles a second-degree thermal burn. Solutions spilled on exposed skin, or on areas covered only by a light layer of clothing, evaporate rapidly, leaving no irritation, or at the most, mild transient redness. Repeated spills on exposed skin may result in dermatitis due to solvent effects.

Results after 1 year of a planned 2-year animal study on the effects of exposure to acrylonitrile have indicated that rats ingesting as little as 35 ppm in their drinking water develop tumors of the central nervous system. The interim results of this study have been supported by a similar study being conducted by the same laboratory, involving exposure of rats by inhalation of acrylonitrile vapor, which has shown similar types of tumors in animals exposed to 80 ppm.

In addition, the preliminary results of an epidemiological study being performed by duPont on a cohort of workers in their Camden, S.C. acrylic fiber plant indicate a statistically significant increase in the incidence of colon and lung cancers among employees exposed to acrylonitrile.

III. SIGNS AND SYMPTOMS OF ACUTE OVEREXPOSURE

Asphyxia and death can occur from exposure to high concentrations of acrylonitrile. Symptoms of overexposure include eye irritation, headache, sneezing, nausea and vomiting, weakness, and light-headedness. Prolonged skin contact can cause blisters on the skin with appearance of a second-degree burn, but with little or no pain. Repeated skin contact may produce scaling dermatitis.

IV. TREATMENT OF ACUTE OVEREXPOSURE

Remove employee from exposure. Immediately flush eyes with water and wash skin with soap or mild detergent and water. If AN has been swallowed, and person is conscious, induce vomiting. Give artificial resuscitation if indicated. More severe cases, such as those associated with loss of consciousness, may be treated by the intravenous administration of sodium nitrite, followed by sodium thiosulfate, although this is not as effective for acrylonitrile poisoning as for inorganic cyanide poisoning.

V. SURVEILLANCE AND PREVENTIVE CONSIDERATIONS

A. As noted above, exposure to acrylonitrile has been linked to increased incidence of cancers of the colon and lung in employees of the duPont acrylic fiber plant in Camden, S.C. In addition, the animal testing of acrylonitrile has resulted in the development of cancers of the central nervous system in rats exposed by either inhalation or ingestion. The physician should be aware of the findings of these studies in evaluating the health of employees exposed to acrylonitrile.

Most reported acute effects of occupational exposure to acrylonitrile are due to its ability to cause tissue anoxia and asphyxia. The effects are similar to those caused by hydrogen cyanide. Liquid acrylonitrile can be absorbed through the skin upon prolonged contact. The liquid readily penetrates leather, and will produce burns of the feet if footwear contaminated with acrylonitrile is not removed.

It is important for the physician to become familiar with the operating conditions in which exposure to acrylonitrile may occur. Those employees with skin diseases may not tolerate the wearing of whatever protective clothing may be necessary to protect them from exposure. In addition, those with chronic respiratory disease may not tolerate the wearing of negative-pressure respirators.

B. Surveillance and screening. Medical histories and laboratory examinations are required for each employee subject to exposure to acrylonitrile above the action level. The employer must screen employees for history of certain medical conditions which might place the employee at increased risk from exposure.

1. *Central nervous system dysfunction.* Acute effects of exposure to acrylonitrile generally involve the central nervous system. Symptoms of acrylonitrile exposure include headache, nausea, dizziness, and general weakness. The animal studies cited above suggest possible carcinogenic effects of acrylonitrile on the central nervous system, since rats exposed by either inhalation or ingestion have developed similar CNS tumors.

2. *Respiratory disease.* The du Pont data indicate an increased risk of lung cancer among employees exposed to acrylonitrile.

3. *Gastrointestinal disease.* The du Pont data incidate an increased risk of cancer of the colon among employees exposed to acrylonitrile. In addition, the animal studies show possible tumor production in the stomachs of the rats in the ingestion study.

4. *Skin disease.* Acrylonitrile can cause skin burns when prolonged skin contact with the liquid occurs. In addition, repeated skin contact with the liquid can cause dermatitis

5. *General.* The purpose of the medical procedures outlined in the standard is to establish a baseline for future health monitoring. Persons unusually susceptible to the effects of anoxia or those with anemia would be expected to be at increased risk. In addition to emphasis on the CNS, respiratory and gastro-intestinal systems, the cardivascular system, liver, and kidney function should also be stressed.

APPENDIX D—SAMPLING AND ANALYTICAL METHODS FOR ACRYLONITRILE

There are many methods available for monitoring employee exposures to acrylonitrile. Most of these involve the use of charcoal tubes and sampling pumps, with analysis by gas chromatograph. The essential differences between the charcoal tube methods include, among others, the use of different desorbing solvents, the use of different lots of charcoal, and the use of different equipment for anaylsis of the samples.

Besides charcoal, considerable work has been performed on methods using porous polymer sampling tubes and passive dosimeters. In addition, there are several portable gas analyzers and monitoring units available on the open market.

This appendix contains details for the methods which have been tested at OSHA Analytical Laboratory in Salt Lake City, and NIOSH in Cincinnati. Each is a variation on NIOSH Method S–156, which is also included for reference. This does not indicate that these methods are the only ones which will be satisfactory. There also may be workplace situations in which these methods are not adequate, due to such factors as high humidity. Copies of the other methods available to OSHA are available in the rulemaking record, and may be obtained from the OSHA Docket Office. These include the Union Carbide, Monsanto, Dow Chemical and Dow Badische methods, as well as NIOSH Method P & CAM 127.

Employers who note problems with sample breakthrough should try larger charcoal tubes. Tubes of larger capacity are available, and are often used for sampling vinyl chloride. In addition, lower flow rates and shorter sampling times should be beneficial in minimizing breakthrough problems.

Whatever method the employer chooses, he must assure himself of the method's accuracy and precision under the unique conditions present in his workplace.

NIOSH Method S–156 (Unmodified)

Analyte: Acrylonitrile.
Matrix: Air.
Procedure: Absorption on charcoal, desorption with methanol, GC.

1. *Principle of the method* (Reference 11.1).

1.1 A known volume of air is drawn through a charcoal tube to trap the organic vapors present.

1.2 The charcoal in the tube is transferred to a small, stoppered sample container, and the analyte is desorbed with methanol.

1.3 An aliquot of the desorbed sample is injected into a gas chromatograph.

1.4 The area of the resulting peak is determined and compared with areas obtained for standards.

2. *Range and sensitivity.*

2.1 This method was validated over the range of 17.5–70.0 mg/cu m at an atmospheric temperature and pressure of 22° C and 760 mm Hg., using a 20-liter sample. Under the conditions of sample size (20 liters) the probable useful range of this method is 4.5–135 mg-cu m. The method is capable of measuring much smaller amounts if the desorption efficiency is adequate. Desorption efficiency must be determined over the range used.

2.2 The upper limit of the range of the method is dependent on the adsorptive capacity of the charcoal tube. This capacity varies with the concentrations of acrylonitrile and other substances in the air. The first section of the charcoal tube was found to hold at least 3.97 mg of acrylonitrile when a test atmosphere containing 92.0 mg/cu m of acrylonitrile in air was sampled 0.18 liter per minute for 240 minutes; at that time the concentration of acrylonitrile in the effluent was less than 5 percent of that in the influent. (The charcoal tube consists of two sections of activated charcoal separated by a section of urethane foam. See section 6.2) If a particular atmosphere is suspected of containing a large amount of contaminant, a smaller sampling volume should be taken.

3. *Interference.*

3.1 When the amount of water in the air is so great that condensation actually occurs in the tube, organic vapors will not be trapped efficiently. Preliminary experiments using toluene indicate that high humidity severely decreases the breakthrough volume.

3.2 When interfering compounds are known or suspected to be present in the air, such information, including their suspected identities, should be transmitted with the sample.

3.3 It must be emphasized that any compound which has the same retention time as the analyte at the operating conditions described in this method is an interference. Retention time data on a single column cannot be considered proof of chemical identity,

3.4 If the possibility of interference exists, separation conditions (column packing, temperature, etc.) must be changed to circumvent the problem.

4. *Precision and accuracy.*

4.1 The Coefficient of Variation (CV_T) for the total analytical and sampling method in the range of 17.5–70.0 mg/cu m was 0.073. This value corresponds to a 3.3 mg/cu m standard deviation at the (previous) OSHA standard level (20 ppm). Statistical information and details of the validation and experimental test procedures can be found in Reference 11.2

4.2 On the average the concentrations obtained at the 20 ppm level using the overall sampling and analytical method were 6.0 percent lower than the "true" concentrations for a limited number of laboratory experiments. Any difference between the "found" and "true" concentrations may not represent a bias on the sampling and analytical method but rather a random variation from the experimentally determined "true" concentration. Therefore, no recovery correction should be applied to the final result in section 10.5

5. *Advantages and disadvantages of the method.*

5.1 The sampling device is small, portable, and involves no liquids. Interferences are minimal, and most of those which do occur can be eliminated by altering chromatographic conditions. The tubes are analyzed by means of a quick, instrumental method.

The method can also be used for the simultaneous analysis of two or more substances suspected to be present in the same sample by simply changing gas chromatographic conditions.

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5.2 One disadvantage of the method is that the amount of sample which can be taken is limited by the number of milligrams that the tube will hold before overloading. When the sample value obtained for the backup section of the charcoal tube exceeds 25 percent of that found on the front section, the possibility of sample loss exists.

5.3 Furthermore, the precision of the method is limited by the reproducibility of the pressure drop across the tubes. This drop will affect the flow rate and cause the volume to be imprecise, because the pump is usually calibrated for one tube only.

6. *Apparatus.*

6.1 A calibrated personal sampling pump whose flow can be determined within ±5 percent at the recommended flow rate. (Reference 11.3).

6.2 Charcoal tubes: Glass tubes with both ends flame sealed, 7 cm long with a 6-mm O.D. and a 4-mm I.D., containing 2 sections of 20/40 mesh activated charcoal separated by a 2-mm portion of urethane foam. The activated charcoals prepared from coconut shells and is fired at 600° C prior to packing. The adsorbing section contains 100 mg of charcoal, the backup section 50 mg. A 3-mm portion of urethane foam is placed between the outlet end of the tube and the backup section. A plug of silicated glass wool is placed in front of the adsorbing section. The pressure drop across the tube must be less than 1 inch of mercury at a flow rate of 1 liter per minute.

6.3 Gas chromatograph equipped with a flame ionization detector.

64. Column (4–ft × ¼-in stainless steel) packed with 50/80 mesh Poropak, type Q.

6.5 An electronic integrator or some other suitable method for measuring peak areas.

6.6 Two-milliliter sample containers with glass stopers or Teflon-lined caps. If an automatic sample injector is used, the associated vials may be used.

6.7 Microliter syringes: 10-microliter, and other convenient sizes for making standards.

6.8 Pipets: 1.0-ml delivery pipets.

6.9 Volumetric flask: 10-ml or convenient sizes for making standard solutions.

7. *Reagents.*

7.1 Chromatographic quality methanol.

7.2 Acrylonitrile, reagent grade.

7.3 Hexane, reagent grade.

7.4 Purified nitrogen.

7.5 Prepurified hydrogen.

7.6 Filtered compressed air.

8. *Procedure.*

8.1 Cleaning of equipment. All glassware used for the laboratory analysis should be detergent washed and thoroughly rinsed with tap water and distilled water.

8.2 Calibration of personal pumps. Each personal pump must be calibrated with a representative charcoal tube in the line. This will minimize errors associated with uncertainties in the sample volume collected.

8.3 Collection and shipping of samples.

8.3.1 Immediately before sampling, break the ends of the tube to provide an opening at least one-half the internal diameter of the tube (2 mm).

8.3.2 The smaller section of charcoal is used as a backup and should be positioned nearest the sampling pump.

8.3.3 The charcoal tube should be placed in a vertical direction during sampling to minimize channeling through the charcoal.

8.3.4 Air being sampled should not be passed through any hose or tubing before entering the charcoal tube.

8.3.5 A maximum sample size of 20 liters is recommended. Sample at a flow of 0.20 liter per minute or less. The flow rate should be known with an accuracy of at least ±5 percent.

8.3.6 The temperature and pressure of the atmosphere being sampled should be recorded. If pressure reading is not available, record the elevation.

8.3.7 The charcoal tubes should be capped with the supplied plastic caps immediately after sampling. Under no circumstances should rubber caps be used.

8.3.8 With each batch of 10 samples submit one tube from the same lot of tubes which was used for sample collection and which is subjected to exactly the same handling as the samples except that no air is drawn through it. Label this as a blank.

8.3.9 Capped tubes should be packed tightly and padded before they are shipped to minimize tube breakage during shipping.

8.3.10 A sample of the bulk material should be submitted to the laboratory in a glass container with a Teflon-lined cap. This sample should not be transported in the same container as the charcoal tubes.

8.4 *Analysis of samples.*

8.4.1 Preparation of samples. In preparation for analysis, each charcoal tube is scored with a file in front of the first section of charcoal and broken open. The glass wool is removed and discarded. The charcoal in the first (larger) section is transferred to a 2-ml stoppered sample container. The separating section of foam is removed and discarded; the second section is transferred to another stoppered container. These two sections are analyzed separately.

8.4.2 Desorption of samples. Prior to analysis, 1.0 ml of methanol is pipetted into each sample container. Desorption should be done for 30 minutes. Tests indicate that this is adequate if the sample is agitated occasionally during this period. If an automatic sample injector is used, the sample vials should be capped as soon as the solvent is added to minimize volatilization.

8.4.3 GC conditions. The typical operating conditions for the gas chromatograph are:

1. 50 ml/min (60 psig) nitrogen carrier gas flow.

2. 65 ml/min (24 psig) hydrogen gas flow to detector.

3. 500 ml/min (50 psig) air flow to detector.

4. 235° C injector temperature.

5. 255° C manifold temperature (detector).

6. 155° C column temperature.

8.4.4 Injection. The first step in the analysis is the injection of the sample into the gas chromatograph. To eliminate difficulties arising from blowback or distillation within the syringe needle, one should employ the solvent flush injection technique. The 10-microliter syringe is first flushed with solvent several times to wet the barrel and plunger. Three microliters of solvent are drawn into the syringe to increase the accuracy and reporducibility of the injected sample volume. The needle is removed from the solvent, and the plunger is pulled back about 0.2 microliter to separate the solvent flush from the sample with a pocket of air to be used as a marker. The needle is then immersed in the sample, and a 5-microliter aliquot is withdrawn, taking into consideration the volume of the needle, since the sample in the needle will be completely injected. After the needle is removed from the sample and prior to injection, the plunger is pulled back 1.2 microliters to minimize evaporation of the sample from the tip of the needle. Observe that the sample occupies 4.9–5.0 microliters in the barrel of the syringe. Duplicate injections of each sample and standard should be made. No more than a 3 percent difference in area is to be expected. An automatic sample injector can be used if it is shown to give reproducibility at least as good as the solvent flush method.

8.4.5 Measurement of area. The area of the sample peak is measured by an electronic integrator or some other suitable form of area measurement, and preliminary results are read from a standard curve prepared as discussed below.

8.5 *Determination of desorption efficiency.*

8.5.1 Importance of determination. The desportion efficiency of a particular compound can vary from one laboratory to another and also from one batch of charcoal to another. Thus, it is necessary to determine at least once the percentage of the specific compound that is removed in the desorption process, provided the same batch of charcoal is used.

8.5.2 Procedure for determining desorption efficiency. Activated charcoal equivalent to the amount in the first section of the sampling tube (100 mg) is measured into a 2.5 in, 4-mm I.D. glass tube, flame sealed at one end. This charcoal must be from the same batch as that used in obtaining the samples and can be obtained from unused charcoal tubes. The open end is capped with Parafilm. A known amount of hexane solution of acrylonitrile containing 0.239 g/ml is injected directly into the activated charcoal with a microliter syringe, and tube is capped with more Parafilm. When using an automatic sample injector, the sample injector vials, capped with Teflon-faced septa, may be used in place of the glass tubes.

The amount injected is equivalent to that present in a 20-liter air sample at the selected level.

Six tubes at each of three levels (0.5X, 1X, and 2X of the standard) are prepared in this manner and allowed to stand for at least overnight to assure complete adsorption of the analyte onto the charcoal. These tubes are referred to as the sample. A parallel blank tube should be treated in the same manner except that no sample is added to it. The sample and blank tubes are desorbed and analyzed in exactly the same manner as the sampling tube described in section 8.4.

Two or three standards are prepared by injecting the same volume of compound into 1.0 ml of methanol with the same syringe used in the preparation of the samples. These are analyzed with the samples.

The desorption efficiency (D.E.) equals the average weight in mg recovered from the tube divided by the weight in mg added to the tube, or

D.E. = Average weight recovered (mg)/
weight added (mg)

The desorption efficiency is dependent on the amount of analyte collected on the charcoal. Plot the desorption efficiency versus weight of analyte found. This curve is used in section 10.4 to correct for adsorption losses.

9. *Calibration and standards.*

It is convenient to express concentration of standards in terms of mg/1.0 ml methanol, because samples are desorbed in this amount of methanol. The density of the analyte is used to convert mg into microliters for easy measurement with a microliter syringe. A series of standards, varying in concentration over the range of interest, is prepared and analyzed under the same GC conditions and during the same time period as the unknown samples. Curves are established by plotting concentration in mg/1.0 ml versus peak area.

NOTE.—Since no internal standard is used in the method, standard solutions must be analyzed at the same time that the sample analysis is done. This will minimize the effect of known day-to-day variations and variations during the same day of the FID response.

10. *Calculations.*

10.1 Read the weight, in mg, corresponding to each peak area from the standard curve. No volume corrections are needed, because the standard curve is based on mg/1.0 ml methanol and the volume of sample injected is identical to the volume of the standards injected.

10.2 Corrections for the blank must be made for each sample.

mg = mg sample − mg blank

Where:
mg sample = mg found in front section of sample tube.
mg sample = mg found in front section of blank tube.

A similar procedure is followed for the backup sections.

10.3 Add the weights found in the front and backup sections to get the total weight in the sample.

10.4 Read the desorption efficiency from the curve (see sec. 8.5.2) for the amount found in the front section. Divide the total weight by this desorption efficiency to obtain the corrected mg/sample.

Corrected mg/sample = Total weight/D.E.

10.5 The concentration of the analyte in the air sampled can be expressed in mg/cu m.

mg/cu m = Corrected mg (section 10.4) × 1,000 (liter/cu m) air volume sampled (liter)

10.6 Another method of expressing concentration is ppm.

ppm = mg/cu × 24.45/M.W. × 760/P × T + 273/298

Where: P = Pressure (mm Hg) of air sampled.
T = Temperature (°C) of air sampled.
24.45 = Molar volume (liter/mole) at 25° C and 760 mm Hg.
M.W. = Molecular weight (g/mole) of analyte.
760 = Standard pressure (mm Hg).
298 = Standard temperature (°K).

11. *References.*

11.1 White L. D. et al., "A Convenient Optimized Method for the Analysis of Selected Solvent Vapors in the Industrial Atmosphere," *Amer. Ind. Hyg. Assoc. J., 31:225* (1970).
11.2 Documentation of NIOSH Validation Tests, NIOSH Validation Tests, NIOSH Contract No. CDC-99-74-45.
11.3 Final Report, NIOSH Contract HSM-99-71-31, "Personal Sampler Pump for Charcoal Tubes," September 15, 1972.

NIOSH MODIFICATION OF NIOSH METHOD S-156

The NIOSH recommended method for low levels for acrylonitrile is a modification of method S-156. It differs in the following respects:
(1) Samples are desorbed using 1 ml of 1 percent acetone in CS_2 rather than methanol.

Column: 20 percent SP-1000 on 80/100 Supelcoport 10 feet × ⅛ inch S.S.

Conditions:
Injector temperature: 200°C.
Detector temperature: 100°C.
Column temperature: 85°C.
Helium flow: 25 ml/min.
Air flow: 450 ml/min.
Hydrogen flow: 55 ml/min.

(3) A 2 μl injection of the desorbed analyte is used.

(4) A sampling rate of 100 ml/min is recommended.

OSHA LABORATORY MODIFICATION OF NIOSH METHOD S—156

Analyte: Acrylonitrile.
Matrix: Air.
Procedure: Adsorption on charcoal, desorption with methanol, GC.

1. *Principle of the Method* (Reference 1).

1.1 A known volume of air is drawn through a charcoal tube to trap the organic vapors present.

1.2 The charcoal in the tube is transferred to a small, stoppered sample vial, and the analyte is desorbed with methanol.
1.3 An aliquot of the desorbed sample is injected into a gas chromatograph.
1.4 The area of the resulting peak is determined and compared with areas obtained for standards.

2. *Advantages and disadvantages of the method.*

2.1 The sampling device is small, portable, and involves no liquids, Interferences are minimal, and most of those which do occur can be eliminated by altering chromatographic conditions. The tubes are analyzed by means of a quick, instrumental method.

2.2 This method may not be adequate for the simultaneous analysis of two or more substances.

2.3 The amount of sample which can be taken is limited by the number of milligrams that the tube will hold before overloading. When the sample value obtained for the backup section of the charcoal tube exceeds 25 percent of that found on the front section, the possibility of sample loss exists.
2.4 The precision of the method is limited by the reproducibility of the pressure drop across the tubes. This drop will affect the flow rate and cause the volume to be imprecise, because the pump is usually calibrated for one tube only.

3. *Apparatus.*

3.1 A calibrated personal sampling pump whose flow can be determined within ±5 percent at the recommended flow rate.

3.2 Charcoal tubes: Glass tube with both ends flame sealed, 7 cm long with a 6-mm O.D. and a 4-mm I.D., containing 2 sections of 20/40 mesh activated charcoal separated by a 2-mm portion of urethane foam. The activated charcoal is prepared from coconut shells and is fired at 600°C prior to packing. The absorbing section contains 100 mg of charcoal, the back-up section 50 mg. A 3-mm portion of urethane foam is placed between the outlet end of the tube and the back-up section. A plug of sililated glass wool is is placed in front of the adsorbing section. The pressure drop across the tube must be less than one inch of mercury at a flow rate of 1 liter per minute.
3.3 Gas chromatograph equipped with a nitrogen phosphorus detector.

3.4 Column (10-ft × ⅛"-in stainless steel) packed with 100/120 Supelcoport coated with 10 percent SP 1000.

3.5 An electronic integrator or some other suitable method for measuring peak areas.

3.6 Two-milliliter sample vials with Teflon-lined caps.

3.7. Microliter syringes: 10-microliter, and other convenient sizes for making standards.

3.8 Pipets: 1.0-ml delivery pipets.

3.9 Volumetric flasks: convenient sizes for making standard solutions.

4. *Reagents.*
4.1 Chromatographic quality methanol.
4.2 Acrylonitrile, reagent grade.

4.3 Filtered compressed air.

4.4 Purified hydrogen.

4.5 Purified helium.

5. *Procedure.*

5.1 Cleaning of equipment. All glassware used for the laboratory analysis should be properly cleaned and free of organics which could interfere in the analysis.

5.2 Calibration of personal pumps. Each pump must be calibrated with a representative charcoal tube in the line.

5.3 Collection and shipping of samples.

5.3.1 Immediately before sampling, break the ends of the tube to provide an opening at least one-half the internal diameter of the tube (2mm).

5.3.2 The smaller section of the charcoal is used as the backup and should be placed nearest the sampling pump.

5.3.3 The charcoal should be placed in a vertical position during sampling to minimize channeling through the charcoal.

5.3.4 Air being sampled should not be passed through any hose or tubing before entering the charcoal tube.

5.3.5 A sample size of 20 liters is recommended. Sample at a flow rate of approximately 0.2 liters per minute. The flow rate should be known with an accuracy of at least ±5 percent.

5.3.6 The temperature and pressure of the atmosphere being sampled should be recorded.

5.3.7 The charcoal tubes should be capped with the supplied plastic caps immediately after sampling. Rubber caps should not be used.

5.3.8 Submit at least one blank tube (a charcoal tube subjected to the same handling procedures, without having any air drawn through it) with each set of samples.

5.3.9 Take necessary shipping and packing precautions to minimize breakage of samples.

5.4 Analysis of samples.

5.4.1 Preparation of samples. In preparation for analysis, each charcoal tube is scored with a file in front of the first section of charcoal and broken open. The glass wool is removed and discarded. The charcoal in the first (larger) section is transferred to a 2-ml vial. The separating section of foam is removed and discarded; the section is transferred to another capped vial. These two sections are analyzed separately.

5.4.2 Desorption of samples. Prior to analysis, 1.0 ml of methanol is pipetted into each sample container. Desorption should be done for 30 minutes in an ultrasonic bath. The sample vials are recapped as soon as the solvent is added.

5.4.2 GC conditions. The typical operating conditions for the gas chromatograph are:

1. 30 ml/min (60 psig) helium carrier gas flow.

2 .3.0 ml/min (30 psig) hydrogen gas flow to detector.

3 .50 ml/min (60 psig) air flow to detector.

4. 200° C injector temperature.

5. 200° C dejector temperature.

6. 100° C column temperature.

5.4.4 Injection. Solvent flush technique or equivalent.

5.4.5 Measurement of area. The area of the sample peak is measured by an electronic integator or some other suitable form of area measurement, and preliminary results are read from a standard curve prepared as discussed below.

5.5 Determination of desorption efficiency.

5.5.1 Importance of determination. The desorption efficiency of a particular compound can vary from one laboratory to another and also from one batch of charcoal to another. Thus, it is necessary to determine, at least once, the percentage of the specific compound that is removed in the desorption process, provided the same batch of charcoal is used.

5.5.2 Procedure for determining desorption efficiency. The reference portion of the charcoal tube is removed. To the remaining portion, amounts representing 0.5X, 1X, and 2X (X represents TLV) based on a 20 l air sample are injected onto several tubes at each level. Dilutions of acrylonitrile with methanol are made to allow injection of measurable quantities. These tubes are then allowed to equilibrate at least overnight. Following equilibration they are analyzed following the same procedure as the samples. A curve of the desorption efficiency

amt recovered/amt added

is plotted versus amount of analyte found. This curve is used to correct for adsorption losses.

6. *Calibration and standards.*

A series of standards, varying in concentration over the range of interest, is prepared and analyzed under the same GC conditions and during the same time period as the unknown samples. Curves are prepared by plotting concentration versus peak area.

NOTE—Since no internal standard is used in the method, standard solutions must be analyzed at the same time that the sample analysis is done. This will minimize the effect of known day-to-day variations and variations during the same day of the NPD response. Multiple injections are necessary.

7. *Calculations.*

Read the weight, corresponding to each peak area from the standard curve, correct for the blank, correct for the desorption efficiency, and make necessary air volume corrections.

8. *Reference.* NIOSH Method S-156.

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APPENDIX A
SUBSTANCE SAFETY DATA SHEET

I. Substance Identification

A. Substance: Ethylene oxide (C_2H_4O).

B. Synonyms: dihydrooxirene, dimethylene oxide, EO, 1,2-epoxyethane, EtO, ETO, oxacyclopropane, oxane, oxidoethane, alpha/beta-oxidoethane, oxiran, oxirane.

C. Ethylene oxide can be found as a liquid or vapor.

D. EtO is used in the manufacture of ethylene glycol, surfactants, ethanolamines, glycol ethers, and other organic chemicals. EtO is also used as a sterilant and fumigant.

E. Appearance and odor: Colorless liquid below 10.7°C (51.3°F) or colorless gas with ether-like odor detected at approximately 700 parts EtO per million parts of air (700 ppm).

F. Permissible exposure: Exposure may not exceed 1 part EtO per million parts of air averaged over the 8-hour work day, nor may short-term exposure exceed 10 parts of EtO per million parts of air averaged over a 15 minute period.

II. Health Hazard Data

A. Ethylene oxide can cause bodily harm if you inhale the vapor, if it comes into contact with your eyes or skin, or if you swallow it.

B. Effects of overexposure:

1. Ethylene oxide in liquid form can cause eye irritation and injury to the cornea, frostbite, and severe irritation and blistering of the skin upon prolonged or confined contact. Ingestion of EtO can cause gastric irritation and liver injury. Acute effects from inhalation of EtO vapors include respiratory irritation and lung injury, headache, nausea, vomiting, diarrhea, shortness of breath, and cyaonosis (blue or purple coloring of skin). Exposure has also been associated with the occurrence of cancer, reproductive effects, mutagenic changes, neurotoxicity, and sensitization.

1. EtO has been shown to cause cancer in laboratory animals and has been associated with higher incidences of cancer in humans. Adverse reproductive effects and chromosome damage may also occur from EtO exposure.

a. Reporting signs and symptoms: You should inform your employer if you develop any signs or symptoms and suspect that they are caused by exposure to EtO.

III. Emergency First Aid Procedures

A. Eye exposure: If EtO gets into your eyes, wash your eyes immediately with large amounts of water, lifting the lower and upper eyelids. Get medical attention immediately. Contact lenses should not be worn when working with this chemical.

B. Skin exposure: If EtO gets on your skin, immediately wash the contaminated skin with water. If EtO soaks through your clothing, especially your shoes, remove the clothing immediately and wash the skin with water using an emergency deluge shower. Get medical attention immediately. Thoroughly wash contaminated clothing before reusing. Contaminated leather shoes or other leather articles should not be reused and should be discarded.

C. Inhalation: If large amounts of EtO are inhaled, the exposed person must be moved to fresh air at once. If breathing has stopped, perform cardiopulmonary resuscitation. Keep the affected person warm and at rest. Get medical attention immediately.

D. Swallowing: When EtO has been swallowed, give the person large quantities of water immediately. After the water has been swallowed, try to get the person to vomit by having him or her touch the back of the throat with his or her finger. Do not make an unconscious person vomit. Get medical atention immediately.

E. Rescue: Move the affected person from the hazardous exposure. If the exposed person has been overcome, attempt rescue only after notifying at least one other person of the emergency and putting into effect established emergency procedures. Do not become a casualty yourself. Understand your emergency rescue procedures and know the location of the emergency equipment before the need arises.

IV. Respirators and Protective Clothing

A. Respirators: You may be required to wear a respirator for nonroutine activities, in emergencies, while your employer is in the process of reducing EtO exposure through engineering controls, and where engineering controls are not feasible. As of the effective date of the standard, only air supplied positive-pressure, full-facepiece respirators are approved for protection against EtO. If air-purifying respirators are worn in the future, they must have a joint Mine Safety and Health Administration (MSHA) and National Institute for Occupational Safety and Health (NIOSH) label of approval for use with ethylene oxide. For effective protection, respirators must fit your face and head snugly. Respirators should not be loosened or removed in work situations where their use is required.

EtO does not have a detectable odor except at levels well above the permissible exposure limits. If you can smell EtO while wearing a respirator, proceed immediately to fresh air. If you experience difficulty breathing while wearing a respirator, tell your employer.

B. Protective clothing: You may be required to wear impermeable clothing, gloves, a face shield, or other appropriate protective clothing to prevent skin contact with liquid EtO or EtO-containing solutions. Where protective clothing is required, your employer must provide clean garments to you as necessary to assure that the clothing protects you adequately.

Replace or repair protective clothing that has become torn or otherwise damaged.

EtO must never be allowed to remain on the skin. Clothing and shoes which are not impermeable to EtO should not be allowed to become contaminated with EtO, and if they

IV. Respirators and Protective Clothing (continued)

do, the clothing should be promptly removed and decontaminated. Contaminated leather shoes should be discarded. Once EtO penetrates shoes or other leather articles, they should not be worn again.

C. Eye protection: You must wear splashproof safety goggles in areas where liquid EtO or EtO-containing solutions may contact your eyes. In addition, contact lenses should not be worn in areas where eye contact with EtO can occur.

V. Precautions for Safe Use, Handling, and Storage

A. EtO is a flammable liquid, and its vapors can easily form explosive mixtures in air.

B. EtO must be stored in tightly closed containers in a cool, well-ventilated area, away from heat, sparks, flames, strong oxidizers, alkalines, and acids, strong bases, acetylide-forming metals such as copper, silver, mercury and their alloys.

C. Sources of ignition such as smoking material, open flames and some electrical devices are prohibited wherever EtO is handled, used, or stored in a manner that could create a potential fire or explosion hazard.

D. You should use non-sparking tools when opening or closing metal containers of EtO, and containers must be bonded and grounded in the rare instances in which liquid EtO is poured or transferred.

E. Impermeable clothing wet with liquid EtO or EtO-containing solutions may be easily ignited. If you are wearing impermeable clothing and are splashed with liquid EtO or EtO-containing solution, you should immediately remove the clothing while under an emergency deluge shower.

F. If your skin comes into contact with liquid EtO or EtO-containing solutions, you should immediately remove the EtO using an emergency deluge shower.

G. You should not keep food, beverages, or smoking materials in regulated areas where employee exposures are above the permissible exposure limits.

H. Fire extinguishers and emergency deluge showers for quick drenching should be readily available, and you should know where they are and how to operate them.

I. Ask your supervisor where EtO is used in your work area and for any additional plant safety and health rules.

VI. Acccess to Information

A. Each year, your employer is required to inform you of the information contained in this standard and appendices for EtO. In addition, your employer must instruct you in the proper work practices for using EtO emergency procedures, and the correct use of protective equipment.

B. Your employer is required to determine whether you are being exposed to EtO. You or your representative has the right to observe employee measurements and to record the results obtained. Your employer is required to inform you of your exposure. If your employer determines that you are being overexposed, he or she is required to inform you of the actions which are being taken to reduce your exposure to within permissible exposure limits.

C. Your employer is required to keep records of your exposures and medical examinations. These exposure records must be kept by the employer for at least thirty (30) years. Medical records must be kept for the period of your employment plus thirty (30) years.

D. Your employer is required to release your exposure and medical records to your physician or designated representative upon your written request.

VII. Sterilant Use of EtO in Hospitals and Health Care Facilities.

This section of Appendix A, for informational purposes, sets forth EPA's recommendations for modifications in workplace design and practice in hospitals and health care facilities for which the Environmental Protection Agency has registered EtO for uses as a sterilant or fumigant under the Federal Insecticide, Fungicide, and Rodenticide Act, 7 U.S.C. 136 *et seq*. These new recommendations, published in the **Federal Register** by EPA at 49 FR 15268, as modified in today's **Register**, are intended to help reduce the exposure of hospital and health care workers to EtO to 1 ppm. EPA's recommended workplace design and workplace practice are as follows:

1. Workplace Design

a. Installation of gas line hand valves. Hand valves must be installed on the gas supply line at the connection to the supply cylinders to minimize leakage during cylinder change.

b. Installation of capture boxes. Sterilizer operations result in a gas/water discharge at the completion of the process. This discharge is routinely piped to a floor drain which is generally located in an equipment or an adjacent room. When the floor drain is not in the same room as the sterilizer and workers are not normally present, all that is necessary is that the room be well ventilated.

The installation of a "capture box" will be required for those work place layouts where the floor drain is located in the same room as the sterilizer or in a room where workers are normally present. A "capture box" is a piece of equipment that totally encloses the floor drain where the discharge from the sterilizer is pumped. The "capture box" is to be vented directly to a non-recirculating or dedicated ventilation system. Sufficient air intake should be allowed at the bottom of the box to handle the volume of air that is ventilated from the top of the box. The "capture box" can be made of metal, plastic, wood or other equivalent material. The box is intended to reduce levels of EtO discharged into the work room atmosphere. The use of a "capture box" is not required if: (1) The vacuum pump discharge floor drain is located in a well ventilated equipment or other room where workers are not normally present or (2) the water sealed vacuum pump discharges directly to a closed sealed sewer line (check local plumbing codes).

If it is impractical to install a vented "capture box" and a well ventilated equipment or other room is not feasible, a box that can be sealed over the floor drain may be used if: (1) The floor drain is located in a room where workers are not normally present and EtO cannot leak into an occupied area, and (2) the sterilizer in use is less than 12 cubic feet in capacity (check local plumbing codes.)

c. Ventilation of aeration units.

i. Existing aeration units. Existing units must be vented to a non-recirculating or dedicated system or vented to an equipment or other room where workers are not normally present and which is well ventilated. Aerator units must be positioned as close as possible to the sterilizer to minimize the exposure from the off-gassing of sterilized items.

ii. Installation of new aerator units (where none exist). New aerator units must be vented as described above for existing aerators. Aerators must be in place by July 1, 1986.

d. Ventilation during cylinder change. Workers may be exposed to short but relatively high levels of EtO during the change of gas cylinders. To reduce exposure from this route, users must select one of three alternatives designed to draw off gas that may be released when the line from the sterilizer to the cylinder is disconnected:

i. Location of cylinders in a well ventilated equipment room or other room where workers are not normally present.

ii. Installation of a flexible hose (at least 4" in diameter) to a non-recirculating or dedicated ventilation system and located in the area of cylinder change in such a way that the hose can be positioned at the point where the sterilizer gas line is disconnected from the cylinder.

iii. Installation of a hood that is part of a non-recirculating or dedicated system and positioned no more than one foot above the point where the change of cylinders takes place.

e. Ventilation of sterilizer door area. One of the major sources of exposure to EtO occurs when the sterilizer door is opened following the completion of the sterilization process. In order to reduce this avenue of exposure, a hood or metal canopy closed on each end must be installed over the sterilizer door. The hood or metal canopy must be connected to a non-recirculating or dedicated ventilation system or one that exhausts gases to a well ventilated equipment or other room where workers are not normally present. A hood or canopy over the sterilizer door is required for use even with those sterilizers that have a purge cycle and must be in place by July 1, 1986.

f. Ventilation of sterilizer relief valve. Sterilizers are typically equipped with a safety relief device to release gas in case of increased pressure in the sterilizer. Generally, such relief devices are used on pressure vessels. Although these pressure relief devices are rarely opened for hospital and health care sterilizers, it is suggested that they be designed to exhaust vapor from the sterilizer by one of the following methods:

i. Through a pipe connected to the outlet of the relief valve ventilated directly outdoors at a point high enough to be away from passers by, and not near any windows that open, or near any air conditioning or ventilation air intakes.

ii. Through a connection to an existing or new non-recirculating or dedicated ventilation system.

iii. Through a connection to a well ventilated equipment or other room where workers are not normally present.

g. Ventilation systems. Each hospital and health care facility affected by this notice that uses EtO for the sterilization of equipment and supplies must have a ventilation system which enables compliance with the requirements of section (b) through (f) in the manner described in these sections and within the timeframes allowed. Thus, each affected hospital and health care facility must have or install a non-recirculating or dedicated ventilation equipment or other room where workers are not normally present in which to vent EtO.

h. Installation of alarm systems. An audible and visual indicator alarm system must be installed to alert personnel of ventilation system failures, i.e., when the ventilation fan motor is not working.

2. Workplace Practices

All the workplace practices discussed in this unit must be permanently posted near the door of each sterilizer prior to use by any operator.

a. Changing of supply line filters.

Filters in the sterilizer liquid line must be changed when necessary, by the following procedure:

i. Close the cylinder valve and the hose valve.

ii. Disconnect the cylinder hose (piping) from the cylinder.

iii. Open the hose valve and bleed slowly into a proper ventilating system at or near the in-use supply cylinders.

iv. Vacate the area until the line is empty.

v. Change the filter.

vi. Reconnect the lines and reverse the value position.

vii. Check hoses, filters, and valves for leaks with a fluorocarbon leak detector (for those sterilizers using the 88 percent chlorofluorocarbon, 12 percent ethylene oxide mixture (12/88)).

b. Restricted access area.

i. Areas involving use of EtO must be designated as restricted access areas. They must be identified with signs or floor marks near the sterilizer door, aerator, vacuum pump floor drain discharge, and in-use cylinder storage.

ii. All personnel must be excluded from the restricted area when certain operations are in progress, such as discharging a vacuum pump, emptying a sterilizer liquid line, or venting a non-purge sterilizer with the door ajar or other operations where EtO might be released directly into the face of workers.

c. Door opening procedures.

i. Sterilizers with purge cycles. A load treated in a sterilizer equipped with a purge cycle should be removed immediately upon completion of the cycle (provided no time is lost opening the door after cycle is completed). If this is not done, the purge cycle should be repeated before opening door.

VII. Sterilant Use in Hospitals, etc. (continued)
2. Workplace Practices (continued)

ii. Sterilizers without purge cycles. For a load treated in a sterilizer not equipped with a purge cycle, the sterilizer door must be ajar 6" for 15 minutes, and then fully opened for at least another 15 minutes before removing the treated load. The length of time of the second period should be established by peak monitoring for one hour after the two 15-minute periods suggested. If the level is above 10 ppm time-weighted average for 8 hours, more time should be added to the second waiting period (door wide open). However, in no case may the second period be shortened to less than 15 minutes.

d. Chamber unloading procedures.

i. Procedures for unloading the chamber must include the use of baskets or rolling carts, or baskets and rolling tables to transfer treated loads quickly, thus avoiding excessive contact with treated articles, and reducing the duration of exposures.

ii. If rolling carts are used, they should be pulled not pushed by the sterilizer operators to avoid offgassing exposure.

e. Maintenance. A written log should be instituted and maintained documenting the date of each leak detection and any maintenance procedures undertaken. This is a suggested use practice and is not required.

i. Leak detection. Sterilizer door gaskets, cylinder and vacuum piping, hoses, filters, and valves must be checked for leaks under full pressure with a Fluorocarbon leak detector (for 12/88 systems only) every two weeks by maintenance personnel. Also, the cyclinder piping connections must be checked after changing cylinders. Particular attention in leak detection should be given to the automatic solenoid valves that control the flow of EtO to the sterilizer. Specifically, a check should be made at the EtO gasline entrance port to the sterilizer, while the sterilizer door is open and the solenoid valves are in a closed position.

ii. Maintenance procedures. Sterilizer/aerator door gaskets, valves, and fittings must be replaced when necessary as determined by maintenance personnel in their biweekly checks; in addition, visual inspection of the door gaskets for cracks, debris, and other foreign substances should be conducted daily by the operator.

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APPENDIX B
SUBSTANCE TECHNICAL GUIDELINES

I. Physical and Chemical Data

A. Substance identification:

1. Synonyms: dihydrooxirene, dimethylene oxide, EO, 1,2-epoxyethane, EtO, ETO, oxacyclopropane, oxane, oxidoethane, alpha/beta-oxidoethane, oxiran, oxirane.

2. Formula: (C_2H_4O).

3. Molecular weight: 44.06

B. Physical data:

1. Boiling point (760 mm Hg): 10.70°C (51.3°F);

2. Specific gravity (water =1): 0.87 (at 20°C or 68°F);

3. Vapor density (air = 1): 1.49;

4. Vapor pressure (at 20°C): 1,095 mm Hg;

5. Solubility in water: complete;

6. Appearance and odor: colorless liquid; gas at temperature above 10.7°F or 51.3°C with ether-like odor above 700 ppm.

II. Fire, Explosion, and Reactivity Hazard Data

A. Fire;

1. Flash point; less than 0°F (open cup);

2. Stability: decomposes violently at temperatures above 800°F;

3. Flammable limits in air, percent by volume: Lower: 3, Upper: 100;

e. Extinguishing media: Carbon dioxide for small fires, polymer or alcohol foams for large fires;

5. Special fire fighting procedures: Dilution of ethylene oxide with 23 volumes of water renders it non-flammable;

6. Unusual fire and explosion hazards: Vapors of EtO will burn without the presence of air or other oxidizers. EtO vapors are heavier than air and may travel along the ground and be ignited by open flames or sparks at locations remote from the site at which EtO is being used.

7. For purposes of compliance with the requirements of 29 CFR 1910.106, EtO is classified as a flammable gas. For example, 7,500 ppm, approximately one-fourth of the lower flammable limit, would be considered to pose a potential fire and explosion hazard.

8. For purposes of compliance with 29 CFR 1910.155, EtO is classified as a Class B fire hazard.

9. For purpose of compliance with 29 CFR 1919.307, locations classified as hazardous due to the presence of EtO shall be Class I.

B. Reactivity:

1. Conditions contributing to instability: EtO will polymerize violently if contaminated with aqueous alkalies, amines, mineral acids, metal chlorides, or metal oxides. Violent decomposition will also occur at temperatures above 800 °F;

2. Incompatibilities: Alkalines and acids;

3. Hazardous decomposition products: Carbon monoxide and carbon dioxide.

III. Spill, Leak, and Disposal Procedures

A. If EtO is spilled or leaked, the following steps should be taken:

1. Remove all ignition sources.

2. The area should be evacuated at once and re-entered only after the area has been thoroughly ventilated and washed down with water.

B. Persons not wearing appropriate protective equipment must be restricted from areas of spills or leaks until cleanup has been completed.

C. Waste disposal methods: Waste material shall be disposed of in a manner that is not hazardous to employees or to the general population. In selecting the method of waste disposal, applicable local, State, and Federal regulations should be consulted.

IV. Monitoring and Measurement Procedures

A. Exposure above the Permissible Exposure limit:

1. Eight-hour exposure evaluation: Measurements taken for the purpose of determining employee exposure under this section are best taken with consecutive samples covering the full shift. Air samples must be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee.)

2. Monitoring techniques: The sampling and analysis under this section may be performed by collection of the EtO vapor on charcoal adsorption tubes or other composition adsorption tubes, with subsequent chemical analysis. Sampling and analysis may also be performed by instruments such as realtime continuous monitoring systems, portable direct reading instruments, or passive dosimeters as long as measurements taken using these methods accurately evaluate the concentration of EtO in employees' breathing zones.

Appendix D describes the validated method of sampling and analysis which has been tested by OSHA for use with EtO. Other available methods are also described in Appendix D. The employer has the obligation of selecting a monitoring method which meets the accuracy and precision requirements of the standard under his unique field conditions. The standard requires that the method of monitoring must be accurate, to a 95 percent confidence level, to plus or minus 25 percent for concentrations of EtO at 1 ppm,

Monitoring and Measurement Procedures (continued)

and to plus or minus 35 percent for concentrations at 0.5 ppm. In addition to the method described in Appendix D, there are numerous other methods available for monitoring for EtO in the workplace. Details on these other methods have been submitted by various companies to the rulemaking record, and are available at the OSHA Docket Office.

B. Since many of the duties relating to employee exposure are dependent on the results of measurement procedures, employers must assure that the evaluation of employee exposures is performed by a technically qualified person.

V. Protective Clothing and Equipment

Employees shall be provided with and be required to wear appropriate protective clothing wherever there is significant potential for skin contact with liquid EtO or EtO-containing solutions. Protective clothing shall include impermeable coveralls or similar full-body work clothing, gloves, and head coverings, as appropriate to protect areas of the body which may come in contact with liquid EtO or EtO-containing solutions.

Employers must ascertain that the protective garments are impermeable to EtO. Permeable clothing, including items made of rubber, and leather shoes should not be allowed to become contaminated with liquid EtO. If permeable clothing does become contaminated, it should be immediately removed, while the employer is under an emergency deluge shower. If leather footwear or other leather garments become wet from EtO they should be discarded and not be worn again, because leather absorbs EtO and holds it against the skin.

Any protective clothing that has been damaged or is otherwise found to be defective should be repaired or replaced. Clean protective clothing should be provided to the employee as necessary to assure employee protection. Whenever impermeable clothing becomes wet with liquid EtO, it should be washed down with water before being removed by the employee. Employees are also required to wear splash-proof safety goggles where there is any possibility of EtO contacting the eyes.

VI. Miscellaneous Precautions

A. Store EtO in tightly closed containers in a cool, well-ventilated area and take all necessary precautions to avoid any explosion hazard.

B. Non-sparking tools must be used to open and close metal containers. These containers must be effectively grounded and bonded.

C. Do not incinerate EtO cartridges, tanks or other containers.

D. Employers shall advise employees of all areas and operations where exposure to EtO occurs.

VII. Common Operations

Common operations in which exposure to EtO is likely to occur include the following: Manufacture of EtO, surfactants, ethanolamines, glycol ethers, and specialty chemicals, and use as a sterilant in the hospital, health product and spice industries.

APPENDIX C
MEDICAL SURVEILLANCE GUIDELINES

I. Route of Entry

Inhalation.

II. Toxicology

Clinical evidence of adverse effects associated with the exposure to EtO is present in the form of increased incidence of cancer in laboratory animals (leukemia, stomach, brain), mutation in offspring in animals, and resorptions and spontaneous abortions in animals and human populations respectively. Findings in humans and experimental animals exposed to airborne concentrations of EtO also indicate damage to the genetic material (DNA). These include hemoglobin alkylation, unscheduled DNA synthesis, sister chromatid exchange chromosomal aberration, and functional sperm abnormalities.

Ethylene oxide in liquid form can cause eye irritation and injury to the cornea, frostbite, severe irritation, and blistering of the skin upon prolonged or confined contact. Ingestion of EtO can cause gastric irritation and liver injury. Other effects from inhalation of EtO vapors include respiratory irritation and lung injury, headache, nausea, vomiting, diarrhea, dyspnea and cyanosis.

III. Signs and Symptoms of Acute Overexposure

The early effects of acute overexposure to EtO are nausea and vomiting, headache, and irritation of the eyes and respiratory passages. The patient may notice a "peculiar taste" in the mouth. Delayed effects can include pulmonary edema, drowsiness, weakness, and incoordination. Studies suggest that blood cell changes, an increase in chromosomal aberrations, and spontaneous abortion may also be causally related to acute overexposure to EtO.

Skin contact with liquid or gaseous EtO causes characteristic burns and possibly even an allergic-type sensitization. The edema and erythema occurring from skin contact with EtO progress to vesiculation with a tendency to coalesce into blebs with desquamation. Healing occurs within three weeks, but there may be a residual brown pigmentation. A 40-80% solution is extremely dangerous, causing extensive blistering after only brief contact. Pure liquid EtO causes frostbite because of rapid evaporation. In contrast, the eye is relatively insensitive to EtO, but there may be some irritation of the cornea.

Most reported acute effects of occupational exposure to EtO are due to contact with EtO in liquid phase. The liquid readily penetrates rubber and leather, and will produce blistering if clothing or footwear contaminated with EtO are not removed.

IV. Surveillance and Preventive Considerations

As noted above, exposure to EtO has been linked to an increased risk of cancer and reproductive effects including descreased male fertility, fetotoxicity, and spontaneous abortion. EtO workers are more likely to have chromosomal damage than similar groups not exposed to EtO. At the present, limited studies of chronic effects in humans resulting from exposure to EtO suggest a causal association with leukemia. Animal studies indicate leukemia and cancers at other sites (brain, stomach) as well. The physician should be aware of the findings of these studies in evaluating the health of employees exposed to EtO.

Adequate screening tests to determine an employee's potential for developing serious chronic diseases, such as cancer, from exposure to EtO do not presently exist. Laboratory tests may, however, give evidence to suggest that an employee is potentially overexposed to EtO. It is important for the physician to become familiar with the operating conditions in which exposure to EtO is likely to occur. The physician also must become familiar with the signs and symptoms that indicate a worker is receiving otherwise unrecognized and unacceptable exposure to EtO. These elements are especially important in evaluating the medical and work histories and in conducting the physical exam. When an unacceptable exposure in an active employee is identified by the physician, measures taken by the employer to lower exposure should also lower the risk of serious long-term consequences.

The employer is required to institute a medical surveillance program for all employees who are or will be exposed to EtO at or above the action level (0.5 ppm) for at least 30 days per year, without regard to respirator use. All examinations and procedures must be performed by or under the supervision of a licensed physician at a reasonable time and place for the employee and at no cost to the employee.

Although broad latitude in prescribing specific tests to be included in the medical surveillance program is extended to the examining physician, OSHA requires inclusion of the following elements in the routine examination:

(i) Medical and work histories with special emphasis directed to symptoms related to the pulmonary, hematologic, neurologic, and reproductive systems and to the eyes and skin.

(ii) Physical examination with particular emphasis given to the pulmonary, hematologic, neurologic, and reproductive systems and to the eyes and skin.

(iii) Complete blood count to include at least a white cell count (including differential cell count), red cell count, hematocrit, and hemoglobin.

(iv) Any laboratory or other test which the examining physician deems necessary by sound medical practice.

If requested by the employee, the medical examinations shall include pregnancy testing or laboratory evaluation of fertility as deemed appropriate by the physician.

In certain cases, to provide sound medical advice to the employer and the employee, the physician must evaluate situations not directly related to EtO. For example, employees

Surveillance and Preventive Considerations (continued)

with skin diseases may be unable to tolerate wearing protective clothing. In addition those with chronic respiratory diseases may not tolerate the wearing of negative pressure (air purifying) respirators. Additional tests and procedures that will help the physician determine which employees are medically unable to wear such respirators should include: An evaluation of cardiovascular function, a baseline chest x-ray to be repeated at five year intervals, and a pulmonary function test to be repeated every three years. The pulmonary function test should include measurement of the employee's forced vital capacity (FVC), forced expiratory volume at one second (FEV1), as well as calculation of the ratios of FEV1 to FVC, and measured FVC and measured FEV1 to expected values corrected for variation due to age, sex, race, and height.

The employer is required to make the prescribed tests available at least annually to employees who are or will be exposed at or above the action level, for 30 or more days per year; more often than specified if recommended by the examining physician; and upon the employee's termination of employment or reassignment to another work area. While little is known about the long-term consequences of high short-term exposures, it appears prudent to monitor such affected employees closely in light of existing health data. The employer shall provide physician recommended examinations to any employee exposed to EtO in emergency conditions. Likewise, the employer shall make available medical consultations including physician recommended exams to employees who believe they are suffering signs or symptoms of exposure to EtO.

The employer is required to provide the physician with the following information: a copy of this standard and its appendices; a description of the affected employee's duties as they relate to the employee exposure level; and information from the employee's previous medical examinations which is not readily available to the examining physician. Making this information available to the physician will aid in the evaluation of the employee's health in relation to assigned duties and fitness to wear personal protective equipment, when required.

The employer is required to obtain a written opinion from the examining physician containing the results of the medical examinations; the physician's opinion as to whether the employee has any detected medical conditions which would place the employee at increased risk of material impairment of his or her health from exposure to EtO; any recommended restrictions upon the employee's exposure to EtO, or upon the use of protective clothing or equipment such as respirators; and a statement that the employee has been informed by the physician of the results of the medical examination and of any medical conditions which require further explanation or treatment. This written opinion must not reveal specific findings or diagnoses unrelated to occupational exposure to EtO, and a copy of the opinion must be provided to the affected employee.

The purpose in requiring the examining physician to supply the employer with a written opinion is to provide the employer with a medical basis to aid in the determination of initial placement of employees and to assess the employee's ability to use protective clothing and equipment.

A number of methods are available for monitoring employee exposures to EtO. Most of these involve the use of charcoal tubes and sampling pumps, followed by analysis of the samples by gas chromatograph. The essential differences between the charcoal tube methods include, among others, the use of different desorbing solvents, the use of different lots of charcoal, and the use of different equipment for analysis of the samples.

Besides charcoal, methods using passive dosimeters, gas sampling bags, impingers, and detector tubes have been utilized for determination of EtO exposure. In addition, there are several commercially available portable gas analyzers and monitoring units.

This appendix contains details for the method which has been tested at the OSHA Analytical Laboratory in Salt Lake City. Inclusion of this method in the appendix does not mean that this method is the only one which will be satisfactory. Copies of descriptions of other methods available are available in the rulemaking record, and may be obtained from the OSHA Docket Office. These include the Union Carbide, Dow Chemical, 3M, and DuPont methods, as well as NIOSH Method S–286. These methods are briefly described at the end of this appendix.

Employers who note problems with sample breakthrough using the OSHA or other charcoal methods should try larger charcoal tubes. Tubes of larger capacity are available. In addition, lower flow rates and shorter sampling times should be beneficial in minimizing breakthrough problems. Whatever method the employer chooses, he must assure himself of the method's accuracy and precision under the unique conditions present in his workplace.

Ethylene Oxide

Method No.: 30.
Matrix: Air.

Target Concentration: 1.0 ppm (1.8 mg/m^3)

Procedure: Samples are collected on two charcoal tubes in series and desorbed with 1% CS_2 in benzene. The samples are derivatized with HBr and treated with sodium carbonate. Analysis is done by gas chromatography with an electron capture detector.

Recommended Air Volume and Sampling Rate: 1 liter and 0.05 Lpm.

Detection Limit of the Overall Procedure: 13.3 ppb (0.024 mg/m^3) (Based on 1.0 liter air sample).

Reliable Quantitation Limit: 52.2 ppb (0.094 mg/m^3) (Based on 1.0 liter air sample).

Standard Error of Estimate: 6.59% (See Backup Section 4.6).

Special Requirements: Samples must be analyzed within 15 days of sampling date.

Status of Method: The sampling and analytical method has been subject to the established evaluation procedures of the Organic Method Evaluations Branch.

Date: August 1981.
Chemist: Wayne D. Potter

Organic Solvents Branch, OSHA Analytical Laboratory, Salt Lake City, Utah

1. General Discussion.

1.1 Background.

1.1.1 History of Procedure.

Ethylene oxide samples analyzed at the OSHA Laboratory have normally been collected on activated charcoal and desorbed with carbon disulfide. The analysis is performed with a gas chromatograph equipped with a FID (Flame ionization detector) as described in NIOSH Method S286 (Ref. 5.1). This method is based on a PEL of 50 ppm and has a detection limit of about 1 ppm.

Recent studies have prompted the need for a method to analyze and detect ethylene oxide at very low concentrations.

Several attempts were made to form an ultraviolet (UV) sensitive derivative with ethylene oxide for analysis with HPLC. Among those tested that gave no detectable product were: p-anisidine, methylimidazole, aniline, and 2,3,6-trichlorobenzoic acid. Each was tested with catalysts such as triethylamine, aluminum chloride, methylene chloride and sulfuric acid but no detectable derivative was produced.

The next derivatization attempt was to react ethylene oxide with HBr to form 2-bromoethanol. This reaction was successful. An ECD (electron capture detector) gave a very good response for 2-bromoethanol due to the presence of bromine. The use of carbon disulfide as the desorbing solvent gave too large a response and masked the 2-bromoethanol. Several other solvents were tested for both their response on the ECD and their ability to desorb ethylene oxide from the charcoal. Among those tested were toluene, xylene, ethyl benzene, hexane, cyclohexane and benzene. Benzene was the only solvent tested that gave a suitable response on the ECD and a high desorption. It was found that the desorption efficiency was improved by using 1% CS_2 with the benzene. The carbon disulfide did not significantly improve the recovery with the other solvents. SKC Lot 120 was used in all tests done with activated charcoal.

1.1.2 Physical Properties (Ref. 5.2-5.4).

Synonyms: Oxirane; dimethylene oxide; 1,2-epoxy-ethane; oxane; C_2H_4O; ETO;

Molecular Weight: 44.06
Boiling Point: 10.7°C (51.3°)
Melting Point:—111°C
Description: Colorless, flammable gas
Vapor Pressure: 1095 mm. at 20 °C
Odor: Ether-like odor
Lower Explosive Limits: 3.0% (by volume)
Flash Point (TOC): Below 0°F
Molecular Structure: CH_2—CH_2

1.2 Limit Defining Parameters.

1.2.1 Detection Limit of the Analytical Procedure.

1. General Discussion. (continued)

The detection limit of the analytical procedure is 12.0 picograms of ethylene oxide per injection. This is the amount of analyte which will give a peak whose height is five times the height of the baseline noise. (See Backup Data Section 4.1).

1.2.2 Detection Limit of the Overall Procedure.

The detection limit of the overall procedure is 24.0 ng of ethylene oxide per sample.

This is the amount of analyte spiked on the sampling device which allows recovery of an amount of analyte equivalent to the detection limit of the analytical procedure. (See Backup Data Section 4.2).

1.2.3 Reliable Quantitation Limit.

The reliable quantitation limit is 94.0 nanograms of ethylene oxide per sample. This is the smallest amount of analyte which can be quantitated within the requirements of 75% recovery and 95% confidence limits. (See Backup Data Section 4.2).

It must be recognized that the reliable quantitation limit and detection limits reported in the method are based upon optimization of the instrument for the smallest possible amount of analyte. When the target concentration of an analyte is exceptionally higher than these limits, they may not be attainable at the routine operating parameters. In this case, the limits reported on analysis reports will be based on the operating parameters used during the analysis of the samples.

1.2.4 Sensitivity.

The sensitivity of the analytical procedure over a concentration range representing 0.5 to 2 times the target concentration based on the recommended air volume is 34105 area units per ug/mL. The sensitivity is determined by the slope of the calibration curve (See Backup Data Section 4.3).

The sensitivity will vary somewhat with the particular instrument used in the analysis.

1.2.5 Recovery.

The recovery of analyte from the collection medium must be 75% or greater. The average recovery from spiked samples over the range of 0.5 to 2 times the target concentration is 88.0% (See Backup Section 4.4). At lower concentrations the recovery appears to be non-linear.

1.2.6 Precision (Analytical Method Only).

The pooled coefficient of variation obtained from replicate determination of analytical standards at 0.5X, 1X and 2X the target concentration is 0.036 (See Backup Data Section 4.5).

1.2.7 Precision (Overall Procedure).

The overall procedure must provide results at the target concentration that are 25% or better at the 95% confidence level. The precision at the 95% confidence level for the 15 day storage test is plus or minus 12.9% (See Backup Data Section 4.6).

This includes an additional plus or minus 5% for sampling error.

1.3 Advantages.

1.3.1 The sampling procedure is convenient.

1.3.2 The analytical procedure is very sensitive and reproducible.

1.3.3 Reanalysis of samples is possible.

1.3.4 Samples are stable for at least 15 days at room temperature.

1.3.5 Interferences are reduced by the longer GC retention time of the new derivative.

1.4 Disadvantages.

1.4.1 Two tubes in series must be used because of possible breakthrough and migration.

1.4.2 The precision of the sampling rate may be limited by the reproducibility of the pressure drop across the tubes. The pumps are usually calibrated for one tube only.

1.4.3 The use of benzene as the desorption solvent increases the hazards of analysis because of the potential carcinogenic effects of benzene.

1.4.4 After repeated injections there can be a buildup of residue formed on the electron capture detector which decreases sensitivity.

1.4.5 Recovery from the charcoal tubes appears to be nonlinear at low concentrations.

2. Sampling Procedure.

2.1 Apparatus.

2.1.1 A calibrated personal sampling pump whose flow can be determined within plus or minus 5% of the recommended flow.

2.1.2 SKC Lot 120 Charcoal tubes: glass tube with both ends flame sealed, 7 cm long with a 6 mm O.D. and a 4-mm I.D., containing 2 sections of coconut shell charcoal separated by a 2-mm portion of urethane foam. The adsorbing section contains 100 mg of charcoal, the backup section 50 mg. A 3-mm portion of urethane foam is placed between the outlet end of the tube and the backup section. A plug of silylated glass wool is placed in front of the adsorbing section.

2.2 Reagents.

2.2.1 None required.

2.3 Sampling Technique.

2.3.1 Immediately before sampling, break the ends of the charcoal tubes. All tubes must be from the same lot.

2.3.2 Connect two tubes in series to the sampling pump with a short section of flexible tubing. A minimum amount of tubing is used to connect the two sampling tubes together. The tube closer to the pump is used as a backup. This tube should be identified as the backup tube.

2.3.3 The tubes should be placed in a vertical position during sampling to minimize channeling.

2.3.4 Air being sampled should not pass through any hose or tubing before entering the charcoal tubes.

2.3.5 Seal the charcoal tubes with plastic caps immediately after sampling. Also, seal each sample with OSHA seals lengthwise.

2.3.6 With each batch of samples, submit at least one blank tube from the same lot used for samples. This tube should be subjected to exactly the same handling as the samples (break, seal, transport) except that no air is drawn through it.

2.3.7 Transport the samples (and corresponding paperwork) to the lab for analysis.

2.3.8 If bulk samples are submitted for analysis, they should be transported in glass containers with Teflon-lined caps. These samples must be mailed separately from the container used for the charcoal tubes.

2.4 Breakthrough.

2.4.1 The breakthrough (5% breakthrough) volume for a 3.0 mg/m ethylene oxide sample stream at approximately 85% relative humidity, 22°C and 633 mm is 2.6 liters sampled at 0.05 liters per minute. This is equivalent to 7.8 μg of ethylene oxide. Upon saturation of the tube it appeared that the water may be displacing ethylene oxide during sampling.

2.5 Desorption Efficiency.

2.5.1 The desorption efficiency, from liquid injection onto charcoal tubes, averaged 88.0% from 0.5 to 2.0 × the target concentration for a 1.0 liter air sample. At lower ranges it appears that the desorption efficiency is non-linear (See Backup Data Section 4.2).

2.5.2 The desorption efficiency may vary from one laboratory to another and also from one lot of charcoal to another. Thus, it is necessary to determine the desorption efficiency for a particular lot of charcoal.

2.6 Recommended Air Volume and Sampling Rate.

2.6.1 The recommended air volume is 1.0 liter.

2.6.2 The recommended maximum sampling rate is 0.05 Lpm.

2.7 Interferences.

2.7.1 Ethylene glycol and Freon 12 at target concentration levels did not interfere with the collection of ethylene oxide.

2.7.2 Suspected interferences should be listed on the sample data sheets.

2.7.3 The relative humidity may affect the sampling procedure.

2.8 Safety Precautions.

2.8.1 Attach the sampling equipment to the employee so that it does not interfere with work performance.

2.8.2 Wear safety glasses when breaking the ends of the sampling tubes.

2.8.3 If possible, place the sampling tubes in a holder so the sharp end is not exposed while sampling.

3. Analytical Method.

3.1 Apparatus.

3.1.1 Gas chromatograph equipped with a linearized electron capture detector.

3.1.2 GC column capable of separating the derivative of ethylene oxide (2-bromoethanol) from any interferences and the 1% CS_2 in benzene solvent. The column used for validation studies was: 10 ft × ⅛ inch stainless steel 20% SP–2100, .1% Carbowax 1500 on 100/120 Supelcoport.

3.1.3 An electronic integrator or some other suitable method of measuring peak areas.

3.1.4 Two milliliter vials with Teflon-lined caps.

3.1.5 Gas tight syringe—500 μL or other convenient sizes for preparing standards.

3.1.6 Microliter syringes—10 μL or other convenient sizes for diluting standards and 1 μL for sample injections.

3.1.7 Pipets for dispensing the 1% CS_2 in benzine solvent. The Glenco 1 mL dispenser is adequate and convenient.

3.1.8 Volumetric flasks—5 mL and other convenient sizes for preparing standards.

3.1.9 Disposable Pasteur pipets.

3.2 Reagents. Q1

3.2.1 Benzene, reagent grade.

3.2.2 Carbon Disulfide, reagent grade.

3.2.3 Ethylene oxide, 99.7% pure.

3.2.4 Hydrobromic Acid, 48% reagent grade.

3.2.5 Sodium Carbonate, anhydrous, reagent grade.

3.2.6 Desorbing reagent, 99% Benzine/1% CS_2.

3. Analytical Method. (continued)

3.3 Sample Preparation.

3.3.1 The front and back sections of each sample are transferred to separate 2-mL vials.

3.3.2 Each sample is desorbed with 1.0 mL of desorbing reagent.

3.3.3 The vials are sealed immediately and allowed to desorb for one hour with occasional shaking.

3.3.4 Desorbing reagent is drawn off the charcoal with a disposable pipet and put into clean 2-mL vials.

3.3.5 One drop of HBr is added to each vial. Vials are resealed and HBr is mixed well with the desorbing reagent.

3.3.6 About 0.15 gram of sodium carbonate is carefully added to each vial. Vials are again resealed and mixed well.

3.4 Standard Preparation.

3.4.1 Standards are prepared by injecting the pure ethylene oxide gas into the desorbing reagent.

3.4.2 A range of standards are prepared to make a calibration curve. A concentration of 1.0 μL of ethylene oxide gas per 1 mL desorbing reagent is equivalent to 1.0 ppm air concentration (all gas volumes at 25°C and 760 mm) for the recommended 1 liter air sample. This amount is uncorrected for desorption efficiency (See Backup Data Section 4.2, for desorption efficiency corrections).

3.4.3 One drop of HBr per mL of standard is added and mixed well.

3.4.4 About 0.15 grams of sodium carbonate is carefully added for each drop of HBr (A small reaction will occur).

3.5 Analysis.

3.5.1 GC conditions.
Nitrogen flow rate—10mL/min.
Injector Temperature—250°C
Detector Temperature—300°C
Column Temperature—100°C
Injection size—0.8 μL
Elution time—3.9 minutes

3.5.2 Peak areas are measured by an integrator or other suitable means.

3.5.3 The integrator results are in area units and a calibration curve is set up with concentration vs. area units.

3.6 Interferences.

3.6.1 Any compound having the same retention time of 2-bromoethanol is a potential interference. Possible interferences should be listed on the sample data sheets.

3.6.2 GC parameters may be changed to circumvent interferences.

3.6.3 There are usually trace contaminants in benzene. These contaminants, however, posed no problem of interference.

3.6.4 Retention time data on a single column is not considered proof of chemical identity. Samples over the 1.0 ppm target level should be confirmed by GC/Mass Spec or other suitable means.

3.7 Calculations.

3.7.1 The concentration in μg/mL for a sample is determined by comparing the area of a particular sample to the calibration curve, which has been prepared from analytical standards.

3.7.2 The amount of analyte in each sample is corrected for desorption efficiency by use of a desorption curve.

3.7.3 Analytical results (A) from the two tubes that compose a particular air sample are added together.

3.7.4 The concentration for a sample is calculated by the following equation:

$$\text{ETO, mg/m}^3 = \frac{AXB}{C}$$

where:
A=μg/mL
B=desorption volume in milliliters
C=air volume in liters.

3.75 To convert mg/m³ to parts per million (ppm) the following relationship is used:

$$\text{ETO, ppm} = \frac{\text{mg/m}^3 \times 24.45}{44.05}$$

where:
mg/m³=results from 3.7.4
24.45=molar volume at 25°C and 760mm Hg
44.05=molecular weight of ETO.

3.8 Safety Precautions

3.8.1 Ethylene oxide and benzene are potential carcinogens and care must be exercised when working with these compounds.

3.8.2 All work done with the solvents (preparation of standards, desorption of samples, etc.) should be done in a hood.

3.8.3 Avoid any skin contact with all of the solvents.

3.8.4 Wear safety glasses at all times.

3.8.5 Avoid skin contact with HBr because it is highly toxic and a strong irritant to eyes and skin.

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4. Backup Data.

4.1 Detection Limit Data.

The detection limit was determined by injecting 0.8 μL of a 0.015 μg/mL standard of ethylene oxide into 1% CS_2 in benzene. The detection limit of the analytical procedure is taken to be 1.20×10^{-5} μg per injection. This is equivalent to 8.3 ppb (0.015 mg/m³) for the recommended air volume.

4.2 Desorption Efficiency.

Ethylene oxide was spiked into charcoal tubes and the following recovery data was obtained.

Amount spiked (μg)	Amount recovered (μg)	Percent recovery
4.5	4.32	96.0
3.0	2.61	87.0
2.25	2.025	90.0
1.5	1.365	91.0
1.5	1.38	92.0
.75	6525	87.0
.375	.315	84.0
.375	.312	83.2
.1875	.151	80.5
.094	.070	74.5

At lower amounts the recovery appears to be non-linear.

4.3 Sensitivity Data.

The following data was used to determine the calibration curve.

Injection	0.5×.75 μg/mL	1×1.5μg/mL	2×3.0 μg/mL
1	30904	59567	111778
2	30987	62914	106016
3	32555	58578	106122
4	32242	57173	109716
X	31672	59558	108408

Slope=34.105.

4.4 Recovery.

The recovery was determined by spiking ethylene oxide onto lot 120 charcoal tubes and desorbing with 1% CS_2 in Benzene. Recoveries were done at 0.5, 1.0, and 2.0 X the target concentration (1 ppm) for the recommended air volume.

Percent Recovery

Sample	0.5x	1.0x	2.0x
1	88.7	95.0	91.7
2	83.8	95.0	87.3
3	84.2	91.0	86.0
4	88.0	91.0	83.0
5	88.0	86.0	85.0
X	86.5	90.5	87.0

Weighted Average=88.2

4.5 Precision of the Analytical Procedure.

The following data was used to determine the precision of the analytical method:

Concentration	0.5×.75 μg/mL	1×1.5 μg/mL	2×3.0 μg/mL
Injection	.7421	1.4899	3.1184
	.7441	1.5826	3.0447
	.7831	1.4628	2.9149
	.7753	1.4244	2.9185
Average	.7612	1.4899	2.9991
Standard Deviation	.0211	.0674	.0998
CV	.0277	.0452	.0333

$$CV = \frac{3(.0277)^2+3(.0452)^2+3(.0333)^2}{3+3+3}$$

CV+0.036

4.6 Storage Data.

Samples were generated at 1.5 mg/m³ ethylene oxide at 85% relative humidity, 22°C and 633 mm. All samples were taken for 20 minutes at 0.05 Lpm. Six samples were analyzed as soon as possible and fifteen samples were stored at refrigerated tempeature (5°C) and fifteen samples were stored at ambient temperature (23°C). These stored samples were analyzed over a period of nineteen days.

Percent Recovery

Day analyzed	Refrigerated	Ambient
1	87.0	87.0
1	93.0	93.0
1	94.0	94.0
1	92.0	92.0
4	92.0	91.0
4	93.0	88.0
4	91.0	89.0
6	92.0	.....
6	92.0	.....
8	.....	92.0
8	.....	86.0
10	91.7	.....
10	95.5	.....
10	95.7	.....
11	.....	90.0
11	.....	82.0
13	78.0	.....
13	81.4	.....
13	82.4	.....
14	.....	78.5
14	.....	72.1
18	66.0	.....
18	68.0	.....
19	.....	64.0
19	.....	77.0

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4.7 Breakthrough Data.

Breakthrough studies were done at 2 ppm (3.6 mg/m³) at approximately 85% relative humidity at 22°C (ambient temperature). Two charcoal tubes were used in series. The backup tube was changed every 10 minutes and analyzed for breakthrough. The flow rate was 0.050 Lpm.

Tube No.	Time (minutes)	Percent breakthrough
1	10	(1)
2	20	(1)
3	30	(1)
4	40	1.23
5	50	3.46
6	60	18.71
7	70	39.2
8	80	53.3
9	90	72.0
10	100	96.0
11	110	113.0
12	120	133.9

[1]None.

The 5% breakthrough volume was reached when 2.6 liters of test atmosphere were drawn through the charcoal tubes.

5. References.

5.1 "NIOSH Manual of Analytical Methods," 2nd ed. NIOSH: Cincinnati, 1977; Method S286.

5.2 "IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Man," International Agency for Research on Cancer: Lyon, 1976; Vol. II, p. 157.

5.3 Sax., N.I. "Dangerous Properties of Industrial Materials," 4th ed.; Van Nostrand Reinhold Company. New York, 1975; p. 741.

5.4 "The Condensed Chemical Dictionary", 9th ed.; Hawley, G.G., ed.; Van Nostrand Reinhold Company, New York, 1977; p. 361.

Summary of Other Sampling Procedures

OSHA believes that several other types of monitoring equipment and techniques exist for monitoring time-weighted averages. Considerable research and method development is currently being performed, which will lead to improvements and a wider variety of monitoring techniques. A combination of monitoring procedures can be used. There probably is no one best method for monitoring personal exposure to ethylene oxide in all cases. There are advantages, disadvantages, and limitations to each method. The method of choice will depend on the need and requirements. Some commonly used methods include the use of charcoal tubes, passive dosimeters, Tedler gas sampling bags, detector tubes, photoionization detection units, infrared detection units and gas chromatographs. A number of these methods are described below.

A. Charcoal Tube Sampling Procedures

Qazi-Ketcham method (Ex-11-133)—This method consists of collecting EtO on Columbia JXC activated carbon, desorbing the EtO with carbon disulfide and analyzing by gas chromatography with flame ionization detection. Union Carbide has recently updated and revalidated this monitoring procedure. This method is capable of determining both eight-hour time-weighted average exposures and short-term exposures. The method was validated to 0.5 ppm. Like other charcoal collecting procedures, the method requires considerable analytical expertise.

ASTM-proposed method—The Ethylene Oxide Industry Council (EOIC) has contracted with Clayton Environmental Consultants, Inc. to conduct a collaborative study for the proposed method. The ASTM-Proposed method is similar to the method published by Qazi and Ketcham in the November 1977 American Industrial Hygiene Association Journal, and to the method of Pilney and coyne, presented at the 1979 American Industrial Hygiene Conference. After the air to be sampled is drawn through an activated charcoal tube, the ethylene oxide is desorbed from the tube using carbon disulfide and is quantitated by gas chromatography utilizing a flame ionization detector. The ASTM-proposed method specifies a large two-section charcoal tube, shipment in dry ice, storage at less than −5°C, and analysis within three weeks to prevent migration and sample loss. Two types of charcoal tubes are being tested—Pittsburgh Coconut-Based (PCB) and columbia JXC charcoal. This collaborative study will give an indication of the inter- and intralaboratory precision and accuracy of the ASTM/proposed method. Several laboratories have considerable expertise using the Qazi-Ketcham and Dow methods.

B. Passive Monitors—Ethylene oxide diffuses into the monitor and is collected in the sampling media. The DuPont Pro-Tek badge collects EtO in an absorbing solution, which is analyzed colorimetrically to determine the amount of EtO present. The 3M 350 badge collects the EtO on chemically treated charcoal. Other passive monitors are currently being developed and tested. Both 3M and DuPont have submitted data indicating their dosimeters meet the precision and accuracy requirements of the proposed ethylene oxide standard. Both presented laboratory validation data to 0.2 ppm (Exs. 11–65, 4–20, 108, 109, 130).

C. Tedlar Gas Sampling Bags-Samples are collected by drawing a known volume of air into a Tedlar gas sampling bag. The ethylene oxide concentration is often determined on-site using a portable gas chromatograph or portable infrared spectometer.

D. Detector tubes—A known volume of air is drawn through a detector tube using a small hand pump. The concentration of EtO is related to the length of stain developed in the tube. Detector tubes are economical, easy to use, and give an immediate readout. Unfortunately, partly because they are nonspecific, their accuracy is often questionable. Since the sample is taken over a short period of time, they may be useful for determining the source of leaks.

E. Direct Reading Instruments—There are numerous types of direct reading instruments, each having its own strengths and weaknesses (Exs. 135B, 135C, 107, 11–78, 11–153). Many are relatively new, offering greater sensitivity and specificity. Popular ethylene oxide direct reading instruments include infrared detection units, photoionization detection units, and gas chromatographs.

Portable infrared analyzers provide an immediate, continuous indication of a concentration value; making them particularly useful for locating high concentration pockets, in leak detection and in ambient air monitoring. In infrared detection units, the amount of infrared light absorbed by the gas being analyzed at selected infrared wavelengths is related to the concentration of a particular component. Various models have either fixed or variable infrared filters, differing cell pathlengths, and microcomputer controls for greater sensitivity, automation, and interference elimination.

A fairly recent detection system is photoionization detection. The molecules are ionized by high energy ultraviolet light. The resulting current is measured. Since different substances have different ionization potentials, other organic compounds may be ionized. The lower the lamp energy, the better the selectivity. As a continuous monitor, photoionization detection can be useful for locating high concentraton pockets, in leak detection, and continuous ambient air monitoring. Both portable and stationary gas chromatographs are available with various types of detectors, including photoionization detectors. A gas chromatograph with a photoionization detector retains the photionization sensitivity, but minimizes or eliminates interferences. For several GC/PID units, the sensitivity is in the 0.1–0.2 ppm EtO range. The GC/PID with microprocessors can sample up to 20 sample points sequentially, calculate and record data, and activate alarms or ventilation systems. Many are quite flexible and can be configured to meet the specific analysis needs for the workplace.

DuPont presented their laboratory validation data of the accuracy of the Qazi-Ketcham charcoal tube, the PCB charcoal tube, Miran 103 IR analyzer, 3M #3550 monitor and the Du Pont C–70 badge. Quoting Elbert V. Kring:

We also believe that OSHA's proposed accuracy in this standard is appropriate. At plus or minus 25 percent at one part per million, and plus or minus 35 percent below that. And, our data indicates their's only one monitoring method, right now, that we've tested thoroughly, that meets that accuracy requirements. That is the Du Pont Pro-Tek badge* * *. We also believe that this kind of data should be confirmed by another independent laboratory, using the same type dynamic chamber testing (Tr. 1470).

Additional data by an independent laboratory following their exact protocol was not submitted. However, information was submitted on comparisons and precision and accuracy of those monitoring procedures which indicate far better precision and accuracy of those monitoring procedures than that obtained by Du Pont (Ex. 4–20, 130, 11–68, 11–133, 130, 135A)

The accuracy of any method depends to a large degree upon the skills and experience of those who not only collect the samples but also those who analyze the samples. Even for methods that are collaboratively tested, some laboratories are closer to the true values than others. Some laboratories may meet the precision and accuracy requirements of the method; others may consistently far exceed them for the same method.

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Appendix A to § 1910.1048—Substance Technical Guidelines for Formalin

The following Substance Technical Guideline for Formalin provides information on uninhibited formalin solution (37% formaldehyde, no methanol stabilizer). It is designed to inform employees at the production level of their rights and duties under the formaldehyde standard whether their job title defines them as workers or supervisors. Much of the information provided is general; however, some information is specific for formalin. When employee exposure to formaldehyde is from resins capable of releasing formaldehyde, the resin itself and other impurities or decomposition products may also be toxic, and employers should include this information as well when informing employees of the hazards associated with the materials they handle. The precise hazards associated with exposure to formaldehyde depend both on the form (solid, liquid, or gas) of the material and the concentration of formaldehyde present. For example, 37–50 percent solutions of formaldehyde present a much greater hazard to the skin and eyes from spills or splashes than solutions containing less than 1 percent formaldehyde Individual Substance Technical Guidelines used by the employer for training employees should be modified to properly give information on the material actually being used.

Substance Identification

Chemical Name: Formaldehyde
Chemical Family: Aldehyde
Chemical Formula: HCHO
Molecular Weight: 30.03
Chemical Abstracts Service Number (CAS Number): 50–00–0

Synonyms: Formalin; Formic Aldehyde; Paraform; Formol; Formalin (Methanol-free); Fyde; Formalith; Methanal; Methyl Aldehyde; Methylene Glycol; Methylene Oxide; Tetraoxymethalene; Oxomethane; Oxymethylene

Components and Contaminants

Percent: 37.0 Formaldehyde
Percent: 63.0 Water

(Note.—Inhibited solutions contain methanol.)

Other Contaminants: Formic acid (alcohol free)
Exposure Limits:
OSHA TWA—1 ppm
OSHA STEL—2 ppm

Physical Data

Description: Colorless liquid, pungent odor
Boiling point: 214 °F (101 °C)
Specific Gravity: 1.08 (H_2O=1 @ 20 °C)
pH: 2.8–4.0
Solubility in Water: Miscible
Solvent Solubility: Soluble in alcohol and acetone
Vapor Density: 1.04 (Air=1 @ 20 °C)
Odor Threshold: 0.8–1 ppm

Fire and Explosion Hazard

Moderate fire and explosion hazard when exposed to heat or flame.

The flash point of 37% formaldehyde solutions is above normal room temperature, but the explosion range is very wide, from 7 to 73% by volume in air.

Reaction of formaldehyde with nitrogen dioxide, nitromethane, perchloric acid and aniline, or peroxyformic acid yields explosive compounds.

Flash Point: 185 °F (85 °C) closed cup
Lower Explosion Limit: 7%
Upper Explosion Limit: 73%
Autoignition Temperature: 806 °F (430 °C)
Flammability Class (OSHA): III A

Extinguishing Media: Use dry chemical, "alcohol foam", carbon dioxide, or water in flooding amounts as fog. Solid streams may not be effective. Cool fire-exposed containers with water from side until well after fire is out.

Use of water spray to flush spills can also dilute the spill to produce nonflammable mixtures. Water runoff, however, should be contained for treatment.

National Fire Protection Association Section 325M Designation:

Health: 2—Materials hazardous to health, but areas may be entered with full-faced mask self-contained breathing apparatus which provides eye protection.

Flammability: 2—Materials which must be moderately heated before ignition will occur. Water spray may be used to extinguish the fire because the material can be cooled below its flash point.

Reactivity: 0—Materials which (in themselves) are normally stable even under fire exposure conditions and which are not reactive with water. Normal fire fighting procedures may be used.

Reactivity

Stability: Formaldehyde solutions may self-polymerize to form paraformaldehyde which precipitates.

Incompatibility (Materials to Avoid): Strong oxidizing agents, caustics, strong alkalies, isocyanates, anhydrides, oxides, and inorganic acids. Formaldehyde reacts with hydrochloric acid to form the potent carcinogen, bis-chloromethyl ether. Formaldehyde reacts with nitrogen dioxide, nitromethane, perchloric acid and aniline, or peroxyformic acid to yield explosive compounds. A violent reaction occurs when formaldehyde is mixed with strong oxidizers.

Hazardous Combustion or Decomposition Products: Oxygen from the air can oxidize formaldehyde to formic acid, especially when heated. Formic acid is corrosive.

Health Hazard Data

Acute Effects of Exposure

Ingestion (Swallowing): Liquids containing 10 to 40% formaldehyde cause severe irritation and inflammation of the mouth, throat, and stomach. Severe stomach pains will follow ingestion with possible loss of consciousness and death. Ingestion of dilute formaldehyde solutions (0.03–0.04%) may cause discomfort in the stomach and pharynx.

Inhalation (Breathing): Formaldehyde is highly irritating to the upper respiratory tract and eyes. Concentrations of 0.5 to 2.0 ppm may irritate the eyes, nose, and throat of some individuals. Concentrations of 3 to 5 ppm also cause tearing of the eyes and are intolerable to some persons. Concentrations of 10 to 20 ppm cause difficulty in breathing, burning of the nose and throat, cough, and heavy tearing of the eyes, and 25 to 30 ppm causes severe respiratory tract injury leading to pulmonary edema and pneumonitis. A concentration of 100 ppm is immediately dangerous to life and health. Deaths from accidental exposure to high concentrations of formaldehyde have been reported.

Skin (Dermal): Formalin is a severe skin irritant and a sensitizer. Contact with formalin causes white discoloration, smarting, drying, cracking, and scaling. Prolonged and repeated contact can cause numbness and a hardening or tanning of the skin. Previously exposed persons may react to future exposure with an allergic eczematous dermatitis or hives.

Eye Contact: Formaldehyde solutions splashed in the eye can cause injuries ranging from transient discomfort to severe, permanent corneal clouding and loss of vision. The severity of the effect depends on the concentration of formaldehyde in the solution and whether or not the eyes are flushed with water immediately after the accident.

Note.—The perception of formaldehyde by odor and eye irritation becomes less sensitive with time as one adapts to formaldehyde. This can lead to overexposure if a worker is relying on formaldehyde's warning properties to alert him or her to the potential for exposure.

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Acute Animal Toxicity:
Oral, rats: LD50=800 mg/kg
Oral, mouse: LD50=42 mg/kg
Inhalation, rats: LCLo=250 mg/kg
Inhalation, mouse: LCLo=900 mg/kg
Inhalation, rats: LC50=590 mg/kg

Chronic Effects of Exposure

Carcinogenicity: Formaldehyde has the potential to cause cancer in humans. Repeated and prolonged exposure increases the risk. Various animal experiments have conclusively shown formaldehyde to be a carcinogen in rats. In humans, formaldehyde exposure has been associated with cancers of the lung, nasopharynx and oropharynx, and nasal passages.

Mutagenicity: Formaldehyde is genotoxic in several *in vitro* test systems showing properties of both an initiator and a promoter.

Toxicity: Prolonged or repeated exposure to formaldehyde may result in respiratory impairment. Rats exposed to formaldehyde at 2 ppm developed benign nasal tumors and changes of the cell structure in the nose as well as inflamed mucous membranes of the nose. Structural changes in the epithelial cells in the human nose have also been observed. Some persons have developed asthma or bronchitis following exposure to formaldehyde, most often as the result of an accidental spill involving a single exposure to a high concentration of formaldehyde.

Emergency and First Aid Procedures

Ingestion (Swallowing): If the victim is conscious, dilute, inactivate, or absorb the ingested formaldehyde by giving milk, activated charcoal, or water. Any organic material will inactivate formaldehyde. Keep affected person warm and at rest. Get medical attention immediately. If vomiting occurs, keep head lower than hips.

Inhalation (Breathing): Remove the victim from the exposure area to fresh air immediately. Where the formaldehyde concentration may be very high, each rescuer must put on a self-contained breathing apparatus before attempting to remove the victim, and medical personnel should be informed of the formaldehyde exposure immediately. If breathing has stopped, give artificial respiration. Keep the affected person warm and at rest. Qualified first-aid or medical personnel should administer oxygen, if available, and maintain the patient's airways and blood pressure until the victim can be transported to a medical facility. If exposure results in a highly irritated upper respiratory tract and coughing continues for more than 10 minutes, the worker should be hospitalized for observation and treatment.

Skin Contact: Remove contaminated clothing (including shoes) immediately. Wash the affected area of your body with soap or mild detergent and large amounts of water until no evidence of the chemical remains (at least 15 to 20 minutes). If there are chemical burns, get first aid to cover the area with sterile, dry dressing, and bandages. Get medical attention if you experience appreciable eye or respiratory irritation.

Eye Contact: Wash the eyes immediately with large amounts of water occasionally lifting lower and upper lids, until no evidence of chemical remains (at least 15 to 20 minutes). In case of burns, apply sterile bandages loosely without medication. Get medical attention immediately. If you have experienced appreciable eye irritation from a splash or excessive exposure, you should be referred promptly to an opthamologist for evaluation.

Emergency Procedures

Emergencies: If you work in an area where a large amount of formaldehyde could be released in an accident or from equipment failure, your employer must develop procedures to be followed in event of an emergency. You should be trained in your specific duties in the event of an emergency, and it is important that you clearly understand these duties. Emergency equipment must be accessible and you should be trained to use any equipment that you might need. Formaldehyde contaminated equipment must be cleaned before reuse.

If a spill of appreciable quantity occurs, leave the area quickly unless you have specific emergency duties. Do not touch spilled material. Designated persons may stop the leak and shut off ignition sources if these procedures can be done without risk. Designated persons should isolate the hazard area and deny entry except for necessary people protected by suitable protective clothing and respirators adequate for the exposure. Use water spray to reduce vapors. Do not smoke, and prohibit all flames or flares in the hazard area.

Special Firefighting Procedures: Learn procedures and responsibilities in the event of a fire in your workplace. Become familiar with the appropriate equipment and supplies and their location. In firefighting, withdraw immediately in case of rising sound from venting safety device or any discoloration of storage tank due to fire.

Spill, Leak, and Disposal Procedures

Occupational Spill: For small containers, place the leaking container in a well ventilated area. Take up small spills with absorbent material and place the waste into properly labeled containers for later disposal. For larger spills, dike the spill to minimize contamination and facilitate salvage or disposal. You may be able to neutralize the spill with sodium hydroxide or sodium sulfite. Your employer must comply with EPA rules regarding the clean-up of toxic waste and notify state and local authorities, if required. If the spill is greater than 1,000 lb/day, it is reportable under EPA's Superfund legislation.

Waste Disposal: Your employer must dispose of waste containing formaldehyde in accordance with applicable local, state, and Federal law and in a manner that minimizes exposure of employees at the site and of the clean-up crew.

Monitoring and Measurement Procedures

Monitoring Requirements: If your exposure to formaldehyde exceeds the 0.5 ppm action level or the 2 ppm STEL, your employer must monitor your exposure. Your employer need not measure every exposure if a "high exposure" employee can be identified. This person usually spends the greatest amount of time nearest the process equipment. If you are a "representative employee", you will be asked to wear a sampling device to collect formaldehyde. This device may be a passive badge, a sorbent tube attached to a pump, or an impinger containing liquid. You should perform your work as usual, but inform the person who is conducting the monitoring of any difficulties you are having wearing the device.

Evaluation of 8-hour Exposure: Measurements taken for the purpose of determining time-weighted average (TWA) exposures are best taken with samples covering the full shift. Samples collected must be taken from the employee's breathing zone air.

Short-term Exposure Evaluation: If there are tasks that involve brief but intense exposure to formaldehyde, employee exposure must be measured to assure compliance with the STEL. Sample collections are for brief periods, only 15 minutes, but several samples may be needed to identify the peak exposure.

Monitoring Techniques: OSHA's only requirement for selecting a method for sampling and analysis is that the methods used accurately evaluate the concentration of formaldehyde in employees' breathing zones. Sampling and analysis may be performed by collection of formaldehyde on liquid or

solid sorbents with subsequent chemical analysis. Sampling and analysis may also be performed by passive diffusion monitors and short-term exposure may be measured by instruments such as real-time continuous monitoring systems and portable direct reading instruments.

Notification of Results: Your employer must inform you of the results of exposure monitoring representative of your job. You may be informed in writing, but posting the results where you have ready access to them constitutes compliance with the standard.

Protective Equipment and Clothing

[Material impervious to formaldehyde is needed if the employee handles formaldehyde solutions of 1% or more. Other employees may also require protective clothing or equipment to prevent dermatitis.]

Respiratory Protection: Use NIOSH-approved full facepiece negative pressure respirators equipped with approved cartridges or canisters within the use limitations of these devices. (Present restrictions on cartridges and canisters do not permit them to be used for a full workshift.) In all other situations, use positive pressure respirators such as the positive-pressure air purifying respirator or the self-contained breathing apparatus (SCBA). If you use a negative pressure respirator, your employer must provide you with fit testing of the respirator at least once a year in accordance with the procedures outlined in Appendix E.

Protective Gloves: Wear protective (impervious) gloves provided by your employer, at no cost, to prevent contact with formalin. Your employer should select these gloves based on the results of permeation testing and in accordance with the ACGIH Guidelines for Selection of Chemical Protective Clothing.

Eye Protection: If you might be splashed in the eyes with formalin, it is essential that you wear goggles or some other type of complete protection for the eye. You may also need a face shield if your face is likely to be splashed with formalin, but you must not substitute face shields for eye protection. (This section pertains to formaldehyde solutions of 1% or more.)

Other Protective Equipment: You must wear protective (impervious) clothing and equipment provided by your employer at no cost to prevent repeated or prolonged contact with formaldehyde liquids. If you are required to change into whole-body chemical protective clothing, your employer must provide a change room for your privacy and for storage of your normal clothing.

If you are splashed with formaldehyde, use the emergency showers and eyewash fountains provided by your employer immediately to prevent serious injury. Report the incident to your supervisor and obtain necessary medical support.

Entry Into an IDLH Atmosphere

Enter areas where the formaldehyde concentration might be 100 ppm or more only with complete body protection including a self-contained breathing apparatus with a full facepiece operated in a positive pressure mode or a supplied air respirator with full facepiece and operated in a positive pressure mode. This equipment is essential to protect your life and health under such extreme conditions.

Engineering Controls

Ventilation is the most widely applied engineering control method for reducing the concentration of airborne substances in the breathing zones of workers. There are two distinct types of ventilation.

Local Exhaust: Local exhaust ventilation is designed to capture airborne contaminants as near to the point of generation as possible. To protect you, the direction of contaminant flow must always be toward the local exhaust system inlet and away from you.

General (Mechanical): General dilution ventilation involves continuous introduction of fresh air into the workroom to mix with the contaminated air and lower your breathing zone concentration of formaldehyde. Effectiveness depends on the number of air changes per hour. Where devices emitting formaldehyde are spread out over a large area, general dilution ventilation may be the only practical method of control.

Work Practices: Work practices and administrative procedures are an important part of a control system. If you are asked to perform a task in a certain manner to limit your exposure to formaldehyde, it is extremely important that you follow these procedures.

Medical Surveillance

Medical surveillance helps to protect employees' health. You are encouraged strongly to participate in the medical surveillance program.

Your employer must make a medical surveillance program available at no expense to you and at a reasonable time and place if you are exposed to formaldehyde at concentrations above 0.5 ppm as an 8-hour average or 2 ppm over any 15-minute period. You will be offered medical surveillance at the time of your initial assignment and once a year afterward as long as your exposure is at least 0.5 ppm (TWA) or 2 ppm (STEL). Even if your exposure is below these levels, you should inform your employer if you have signs and symptoms that you suspect, through your training, are related to your formaldehyde exposure because you may need medical surveillance to determine if your health is being impaired by your exposure.

The surveillance plan includes:

(a) A medical disease questionnaire.

(b) A physical examination if the physician determines this is necessary.

If you are required to wear a respirator, your employer must offer you a physical examination and a pulmonary function test every year.

The physician must collect all information needed to determine if you are at increased risk from your exposure to formaldehyde. At the physician's discretion, the medical examination may include other tests, such as a chest x-ray, to make this determination.

After a medical examination the physician will provide your employer with a written opinion which includes any special protective measures recommended and any restrictions on your exposure. The physician must inform you of any medical conditions you have which would be aggravated by exposure to formaldehyde.

All records from your medical examinations, including disease surveys, must be retained at your employer's expense.

Emergencies

If you are exposed to formaldehyde in an emergency and develop signs or symptoms associated with acute toxicity from formaldehyde exposure, your employer must provide you with a medical examination as soon as possible. This medical examination will include all steps necessary to stabilize your health. You may be kept in the hospital for observation if your symptoms are severe to ensure that any delayed effects are recognized and treated.

Appendix B to § 1910.1048—Sampling Strategy and Analytical Methods for Formaldehyde

To protect the health of employees, exposure measurements must be unbiased and representative of employee exposure. The proper measurement of employee exposure requires more than a token commitment on the part of the employer. OSHA's mandatory requirements establish a

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baseline; under the best of circumstances all questions regarding employee exposure will be answered. Many employers, however, will wish to conduct more extensive monitoring before undertaking expensive commitments, such as engineering controls, to assure that the modifications are truly necessary. The following sampling strategy, which was developed at NIOSH by Nelson A. Leidel, Kenneth A. Busch, and Jeremiah R. Lynch and described in NIOSH publication No. 77-173 (Occupational Exposure Sampling Strategy Manual) will assist the employer in developing a strategy for determining the exposure of his or her employees.

There is no one correct way to determine employee exposure. Obviously, measuring the exposure of every employee exposed to formaldehyde will provide the most information on any given day. Where few employees are exposed, this may be a practical solution. For most employers, however, use of the following strategy will give just as much information at less cost.

Exposure data collected on a single day will not automatically guarantee the employer that his or her workplace is always in compliance with the formaldehyde standard. This does not imply, however, that it is impossible for an employer to be sure that his or her worksite is in compliance with the standard. Indeed, a properly designed sampling strategy showing that all employees are exposed below the PELs, at least with a 95 percent certainty, is compelling evidence that the exposure limits are being achieved provided that measurements are conducted using valid sampling strategy and approved analytical methods.

There are two PELs, the TWA concentration and the STEL. Most employers will find that one of these two limits is more critical in the control of their operations, and OSHA expects that the employer will concentrate monitoring efforts on the critical component. If the more difficult exposure is controlled, this information, along with calculations to support the assumptions, should be adequate to show that the other exposure limit is also being achieved.

Sampling Strategy

Determination of the Need for Exposure Measurements

The employer must determine whether employees may be exposed to concentrations in excess of the action level. This determination becomes the first step in an employee exposure monitoring program that minimizes employer sampling burdens while providing adequate employee protection. If employees may be exposed above the action level, the employer must measure exposure. Otherwise, an objective determination that employee exposure is low provides adequate evidence that exposure potential has been examined.

The employer should examine all available relevant information, *eg.* insurance company and trade association data and information from suppliers or exposure data collected from similar operations. The employer may also use previously-conducted sampling including area monitoring. The employer must make a determination relevant to each operation although this need not be on a separate piece of paper. If the employer can demonstrate conclusively that no employee is exposed above the action level or the STEL through the use of objective data, the employer need proceed no further on employee exposure monitoring until such time that conditions have changed and the determination is no longer valid.

If the employer cannot determine that employee exposure is less than the action level and the STEL, employee exposure monitoring will have to be conducted.

Workplace Material Survey

The primary purpose of a survey of raw material is to determine if formaldehyde is being used in the work environment and if so, the conditions under which formaldehyde is being used.

The first step is to tabulate all situations where formaldehyde is used in a manner such that it may be released into the workplace atmosphere or contaminate the skin. This information should be available through analysis of company records and information on the MSDSs available through provisions of this standard and the Hazard Communication standard.

If there is an indication from materials handling records and accompanying MSDSs that formaldehyde is being used in the following types of processes or work operations, there may be a potential for releasing formaldehyde into the workplace atmosphere:

(1) Any operation that involves grinding, sanding, sawing, cutting, crushing, screening, sieving, or any other manipulation of material that generates formaldehyde-bearing dust

(2) Any processes where there have been employee complaints or symptoms indicative of exposure to formaldehyde

(3) Any liquid or spray process involving formaldehyde

(4) Any process that uses formaldehyde in preserved tissue

(5) Any process that involves the heating of a formaldehyde-bearing resin. Processes and work operations that use formaldehyde in these manners will probably require further investigation at the worksite to determine the extent of employee monitoring that should be conducted.

Workplace Observations

To this point, the only intention has been to provide an indication as to the existence of potentially exposed employees. With this information, a visit to the workplace is needed to observe work operations, to identify potential health hazards, and to determine whether any employees may be exposed to hazardous concentrations of formaldehyde.

In many circumstances, sources of formaldehyde can be identified through the sense of smell. However, this method of detection should be used with caution because of olfactory fatigue.

Employee location in relation to source of formaldehyde is important in determining if an employee may be significantly exposed to formaldehyde. In most instances, the closer a worker is to the source, the higher the probability that a significant exposure will occur.

Other characteristics should be considered. Certain high temperature operations give rise to higher evaporation rates. Locations of open doors and windows provide natural ventilation that tend to dilute formaldehyde emissions. General room ventilation also provides a measure of control.

Calculation of Potential Exposure Concentrations

By knowing the ventilation rate in a workplace and the quantity of formaldehyde generated, the employer may be able to determine by calculation if the PELs might be exceeded. To account for poor mixing of formaldehyde into the entire room, locations of fans and proximity of employees to the work operation, the employer must include a safety factor. If an employee is relatively close to a source, particularly if he or she is located downwind, a safety factor of 100 may be necessary. For other situations, a factor of 10 may be acceptable. If the employer can demonstrate through such calculations that employee exposure does not exceed the action level or the STEL, the employer may use this information as objective data to

demonstrate compliance with he standard.

Sampling Strategy

Once the employer determines that there is a possibility of substantial employee exposure to formaldehyde, the employer is obligated to measure employee exposure.

The next step is selection of a maximum risk employee. When there are different processes where employees may be exposed to formaldehyde, a maximum risk employee should be selected for each work operation.

Selection of the maximum risk employee requires professional judgment. The best procedure for selecting the maximum risk employee is to observe employees and select the person closest to the source of formaldehyde. Employee mobility may affect this selection; *eg.* if the closest employee is mobile in his tasks, he may not be the maximum risk employee. Air movement patterns and differences in work habits will also affect selection of the maximum risk employee.

When many employees perform essentially the same task, a maximum risk employee cannot be selected. In this circumstance, it is necessary to resort to random sampling of the group of workers. The objective is to select a subgroup of adequate size so that there is a high probability that the random sample will contain at least one worker with high exposure if one exists. The number of persons in the group influences the number that need to be sampled to ensure that at least one individual from the highest 10 percent exposure group is contained in the sample. For example, to have 90 percent confidence in the results, if the group size is 10, nine should be sampled; for 50, only 18 need to be sampled.

If measurement shows exposure to formaldehyde at or above the action level or the STEL, the employer needs to identify all other employees who may be exposed at or above the action level or STEL and measure or otherwise accurately characterize the exposure of these employees.

Whether representative monitoring or random sampling are conducted, the purpose remains the same—to determine if the exposure of any employee is above the action level. If the exposure of the most exposed employee is less than the action level and the STEL, regardless of how the employee is identified, then it is reasonable to assume that measurements of exposure of the other employees in that operation would be below the action level and the STEL.

Exposure Measurements

There is no "best" measurement strategy for all situations. Some elements to consider in developing a strategy are:

(1) Availability and cost of sampling equipment

(2) Availability and cost of analytic facilities

(3) Availability and cost of personnel to take samples

(4) Location of employees and work operations

(5) Intraday and interday variations in the process

(6) Precision and accuracy of sampling and analytic methods, and

(7) Number of samples needed.

Samples taken for determining compliance with the STEL differ from those that measure the TWA concentration in important ways. STEL samples are best taken in a nonrandom fashion using all available knowledge relating to the area, the individual, and the process to obtain samples during periods of maximum expected concentrations. At least three measurements on a shift are generally needed to spot gross errors or mistakes; however, only the highest value represents the STEL.

If an operation remains constant throughout the workshift, a much greater number of samples would need to be taken over the 32 discrete nonoverlapping periods in an 8-hour workshift to verify compliance with a STEL. If employee exposure is truly uniform throughout the workshift, however, an employer in compliance with the 1 ppm TWA would be in compliance with the 2 ppm STEL, and this determination can probably be made using objective data.

Need to Repeat the Monitoring Strategy

Interday and intraday fluctuations in employee exposure are mostly influenced by the physical processes that generate formaldehyde and the work habits of the employee. Hence, in-plant process variations influence the employer's determination of whether or not additional controls need to be imposed. Measurements that employee exposure is low on a day that is not representative of worst conditions may not provide sufficient information to determine whether or not additional engineering controls should be installed to achieve the PELs.

The person responsible for conducting sampling must be aware of systematic changes which will negate the validity of the sampling results. Systematic changes in formaldehyde exposure concentration for an employee can occur due to:

(1) The employee changing patterns of movement in the workplace

(2) Closing of plant doors and windows

(3) Changes in ventilation from season to season

(4) Decreases in ventilation efficiency or abrupt failure of engineering control equipment

(5) Changes in the production process or work habits of the employee.

Any of these changes, if they may result in additional exposure that reaches the next level of action (*i.e.* 0.5 or 1.0 ppm as an 8-hr average or 2 ppm over 15 minutes) require the employer to perform additional monitoring to reassess employee exposure.

A number of methods are suitable for measuring employee exposure to formaldehyde or for characterizing emissions within the worksite. The preamble to this standard describes some methods that have been widely used or subjected to validation testing. A detailed analytical procedure derived from the OSHA Method 52 for acrolein and formaldehyde is presented below for informational purposes.

Inclusion of OSHA's method in this appendix in no way implies that it is the only acceptable way to measure employee exposure to formaldehyde. Other methods that are free from significant interferences and that can determine formaldehyde at the permissible exposure limits within ±25 percent of the "true" value at the 95 percent confidence level are also acceptable. Where applicable, the method shou1d a1so be capab1e of measuring formaldehyde at the action level to ±35 percent of the "true" value with a 95 percent confidence level. OSHA encourages emp1oyers to choose methods that will be best for their individual needs. The employer must exercise caution, however, in choosing an appropriate method since some techniques suffer from interferences that are likely to be present in workplaces of certain industry sectors where formaldehyde is used.

OSHA's Analytical Laboratory Method

Method No: 52
Matrix: Air
Target Concentration: 1 ppm (1.2 mg/m³)
Procedures: Air samples are collected by drawing known volumes of air through sampling tubes containing XAD–2 adsorbent which have been coated with 2-(hydroxymethyl) piperidine. The samples are desorbed with toluene and then analyzed by gas

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chromatography using a nitrogen selective detector.

Recommended Sampling Rate and Air Volumes: 0.1 L/min and 24 L

Reliable Quantitation Limit: 16 ppb (20 $\mu g/m^3$)

Standard Error of Estimate at the Target Concentration: 7.3%

Status of the Method: A sampling and analytical method that has been subjected to the established evaluation procedures of the Organic Methods Evaluation Branch.

Date: March 1985

1. General Discussion

1.1 *Background:* The current OSHA method for collecting acrolein vapor recommends the use of activated 13X molecular sieves. The samples must be stored in an ice bath during and after sampling and also they must be analyzed within 48 hours of collection. The current OSHA method for collecting formaldehyde vapor recommends the use of bubblers containing 10% methanol in water as the trapping solution.

This work was undertaken to resolve the sample stability problems associated with acrolein and also to eliminate the need to use bubb1ers to sample formaldehyde. A goal of this work was to develop and/or to evaluate a common sampling and analytical procedure for acrolein and formaldehyde.

NIOSH has developed independent methodologies for acrolein and formaldehyde which recommend the use of reagent-coated adsorbent tubes to collect the aldehydes as stable derivatives. The formaldehyde sampling tubes contain Chromosorb 102 adsorbent coated with N-benzylethanolamine (BEA) which reacts with formaldehyde vapor to form a stable oxazolidine compound. The acrolein sampling tubes contain XAD–2 adsorbent coated with 2-(hydroxymethyl)piperidine (2–HMP) which reacts with acrolein vapor to form a different, stable oxazolidine derivative. Acrolein does not appear to react with BEA to give a suitable reaction product. Therefore, the formaldehyde procedure cannot provide a common method for both aldehydes. However, formaldehyde does react with 2–HMP to form a very suitable reaction product. It is the quantitative reaction of acrolein and formaldehyde with 2–HMP that provides the basis for this evaluation.

This sampling and analytical procedure is very similar to the method recommended by NIOSH for acrolein. Some changes in the NIOSH methodology were necessary to permit the simultaneous determination of both aldehydes and also to accommodate OSHA laboratory equipment and analytical techniques.

1.2 *Limit-defining parameters:* The analyte air concentrations reported in this method are based on the recommended air volume for each analyte collected separately and a desorption volume of 1 mL. The amounts are presented as acrolein and/or formaldehyde, even though the derivatives are the actual species analyzed.

1.2.1 *Detection limits of the analytical procedure:* The detection limit of the analytical procedure was 386 pg per injection for formaldehyde. This was the amount of analyte which gave a peak whose height was about five times the height of the peak given by the residual formaldehyde derivative in a typical blank front section of the recommended sampling tube.

1.2.2 *Detection limits of the overall procedure:* The detection limits of the overall procedure were 482 ng per sample (16 ppb or 20 $\mu g/m^3$ for formaldehyde). This was the amount of analyte spiked on the sampling device which allowed recoveries approximately equal to the detection limit of the analytical procedure.

1.2.3 *Reliable quantitation limits:* The reliable quantitation limit was 482 ng per sample (16 ppb or 20 $\mu g/m^3$) for formaldehyde. These were the smallest amounts of analyte which could be quantitated within the limits of a recovery of at least 75% and a precision ($\pm$1.96 SD) of $\pm$25% or better.

The reliable quantitation limit and detection limits reported in the method are based upon optimization of the instrument for the smallest possible amount of analyte. When the target concentration of an analyte is exceptionally higher than these limits, they may not be attainable at the routine operating parameters.

1.2.4 *Sensitivity:* The sensitivity of the analytical procedure over concentration ranges representing 0.4 to 2 times the target concentration, based on the recommended air volumes, was 7,589 area units per $\mu g/mL$ for formaldehyde. This value was determined from the slope of the calibration curve. The sensitivity may vary with the particular instrument used in the analysis.

1.2.5 *Recovery:* The recovery of formaldehyde from samples used in an 18-day storage test remained above 92% when the samples were stored at ambient temperature. These values were determined from regression lines which were calculated from the storage data. The recovery of the analyte from the collection device must be at least 75% following storage.

1.2.6 *Precision (analytical method only):* The pooled coefficient of variation obtained from replicate determinations of analytical standards over the range of 0.4 to 2 times the target concentration was 0.0052 for formaldehyde (Section 4.3).

1.2.7 *Precision (overall procedure):* The precision at the 95% confidence level for the ambient temperature storage tests was $\pm$14.3% for formaldehyde. These values each include an additional $\pm$5% for sampling error. The overall procedure must provide results at the target concentrations that are $\pm$25% at the 95% confidence level.

1.2.8 *Reproducibility:* Samples collected from controlled test atmospheres and a draft copy of this procedure were given to a chemist unassociated with this evaluation. The formaldehyde samples were analyzed following 15 days storage. The average recovery was 96.3% and the standard deviation was 1.7%.

1.3 *Advantages:*

1.3.1 The sampling and analytical procedures permit the simultaneous determination of acrolein and formaldehyde.

1.3.2 Samples are stable following storage at ambient temperature for at least 18 days.

1.4 *Disadvantages:* None.

2. Sampling Procedure

2.1 *Apparatus:*

2.1.1 Samples are collected by use of a personal sampling pump that can be calibrated to within $\pm$5% of the recommended 0.1 L/min sampling rate with the sampling tube in line.

2.1.2 Samples are collected with laboratory prepared sampling tubes. The sampling tube is constructed of silane treated glass and is about 8-cm long. The ID is 4 mm and the OD is 6 mm. One end of the tube is tapered so that a glass wool end plug will hold the contents of the tube in place during sampling. The other end of the sampling tube is open to its full 4-mm ID to facilitate packing of the tube. Both ends of the tube are fire-polished for safety. The tube is packed with a 75-mg backup section, located nearest the tapered end and a 150-mg sampling section of pretreated XAD–2 adsorbent which has been coated with 2–HMP. The two sections of coated adsorbent are separated and retained with small plugs of silanized glass wool. Following packing, the sampling tubes are sealed with two 7/32 inch OD plastic end caps. Instructions for the

pretreatment and the coating of XAD–2 adsorbent are presented in Section 4 of this method.

2.1.3 Sampling tubes, similar to those recommended in this method, are marketed by Supelco, Inc. These tubes were not available when this work was initiated; therefore, they were not evaluated.

2.2 *Reagents:* None required.

2.3 *Technique:*

2.3.1 Properly label the sampling tube before sampling and then remove the plastic end caps.

2.3.2 Attach the sampling tube to the pump using a section of flexible plastic tubing such that the large; front section of the sampling tube is exposed directly to the atmosphere. Do not place any tubing ahead of the sampling tube. The sampling tube should be attached in the worker's breathing zone in a vertical manner such that it does not impede work performance.

2.3.3 After sampling for the appropriate time, remove the sampling tube from the pump and then seal the tube with plastic end caps.

2.3.4 Include at least one blank for each sampling set. The blank should be handled in the same manner as the samples with the exception that air is not drawn through it.

2.3.5 List any potential interferences on the sample data sheet.

2.4 *Breakthrough:*

2.4.1 Breakthrough was defined as the relative amount of analyte found on a backup sample in relation to the total amount of analyte collected on the sampling train.

2.4.2 For formaldehyde collected from test atmospheres containing 6 times the PEL, the average 5% breakthrough air volume was 41 L. The sampling rate was 0.1 L/min and the average mass of formaldehyde collected was 250 µg.

2.5 *Desorption Efficiency:* No desorption efficiency corrections are necessary to compute air sample results because analytical standards are prepared using coated adsorbent. Desorption efficiencies were determined, however, to investigate the recoveries of the analytes from the sampling device. The average recovery over the range of 0.4 to 2 times the target concentration, based on the recommended air volumes, was 96.2% for formaldehyde. Desorption efficiencies were essentially constant over the ranges studied.

2.6 *Recommended Air Volume and Sampling Rate:*

2.6.1 The recommended air volume for formaldehyde is 24 L.

2.6.2 The recommended sampling rate is 01. L/min.

2.7 *Interferences:*

2.7.1 Any collected substance that is capable of reacting 2-HMP and thereby depleting the derivatizing agent is a potential interference. Chemicals which contain a carbonyl group, such as acetone, may be capable or reacting with 2-HMP.

2.7.2 There are no other known interferences to the sampling method.

2.8 *Safety Precautions:*

2.8.1 Attach the sampling equipment to the worker in such a manner that it well not interfere with work performance or safety.

2.8.2 Follow all safety practices that apply to the work area being sampled.

3. Analytical Procedure

3.1 *Apparatus:*

3.1.1 A gas chromatograph (GC), equipped with a nitrogen selective detector. A Hewlett-Packard Model 5840A GC fitted with a nitrogen-phosphorus flame ionization detector (NPD) was used for this evaluation. Injections were performed using a Hewlett-Packard Model 7671A automatic sampler.

3.1.2 A GC column capable of resolving the analytes from any interference. A 6 ft x ¼ in OD (2mm ID) glass GC column containing 10% UCON 50–HB–5100 + 2% KOH on 80/100 mesh Chromosorb W–AW was used for the evaluation. Injections were performed on-column.

3.1.3 Vials, glass 2-mL with Teflon-lined caps.

3.1.4 Volumetric flasks, pipets, and syringes for preparing standards, making dilutions, and performing injections.

3.2 *Reagents:*

3.2.1 Toluene and dimethylformamide. Burdick and Jackson solvents were used in this evaluation.

3.2.2 Helium, hydrogen, and air, GC grade.

3.2.3 Formaldehyde, 37%, by weight, in water. Aldrich Chemical, ACS Reagent Grade formaldehyde was used in this evaluation.

3.2.4 Amberlite XAD–2 adsorbent coated with 2-(hydroxymethyl—piperidine (2-HMP), 10% by weight (Section 4).

3.2.5 Desorbing solution with internal standard. This solution was prepared by adding 20 µL of dimethylformamide to 100 mL of toluene.

3.3 *Standard preparation:*

3.3.1 *Formaldehyde:* Prepare stock standards by diluting known volumes of 37% formaldehyde solution with methanol. A procedure to determine the formaldehyde content of these standards is presented in Section 4. A standard containing 7.7 mg/mL formaldehyde was prepared by diluting 1 mL of the 37% reagent to 50 mL with methanol.

3.3.2 It is recommended that analytical standards be prepared about 16 hours before the air samples are to be analyzed in order to ensure the complete reaction of the analytes with 2–HMP. However, rate studies have shown the reaction to be greater than 95% complete after 4 hours. Therefore, one or two standards can be analyzed after this reduced time if sample results are outside the concentration range of the prepared standards.

3.3.3 Place 150-mg portions of coated XAD–2 adsorbent, from the same lot number as used to collect the air samples, into each of several glass 2-mL vials. Seal each vial with a Teflon-lined cap.

3.3.4 Prepare fresh analytical standards each day by injecting appropriate amounts of the diluted analyte directly onto 150-mg portions of coated adsorbent. It is permissible to inject both acrolein and formaldehyde on the same adsorbent portion. Allow the standards to stand at room temperature. A standard, approximately the target levels, was prepared by injecting 11 µL of the acrolein and 12 µL of the formaldehyde stock standards onto a single coated XAD–2 adsorbent portion.

3.3.5 Prepare a sufficient number of standards to generate the calibration curves. Analytical standard concentrations should bracket sample concentrations. Thus, if samples are not in the concentration range of the prepared standards, additional standards must be prepared to determine detector response.

3.3.7 Desorb the standards in the same manner as the samples following the 16-hour reaction time.

3.4 *Sample preparation:*

3.4.1 Transfer the 150-mg section of the sampling tube to a 2-mL vial. Place the 75-mg section in a separate vial. If the glass wool plugs contain a significant number of adsorbent beads, place them with the appropriate sampling tube section. Discard the glass wool plugs if they do not contain a significant number of adsorbent beads.

3.4.2 Add 1 mL of desorbing solution to each vial.

3.4.3 Seal the vials with Teflon-lined caps and then allow them to desorb for one hour. Shake the vials by hand with vigorous force several times during the desorption time.

3.4.4 Save the used sampling tubes to be cleaned and recycled.

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3.5 *Analysis:*

3.5.1 *GC Conditions*

Column Temperature:

Bi-level temperature program—First level: 100 to 140 °C at 4 °C/min following completion of the first level.

Second level: 140 to 180 °C at 20 °C/min following completion of the first level.

Isothermal period: Hold column at 180 °C until the recorder pen returns to baseline (usually about 25 min after injection).

Injector temperature: 180 °C

Helium flow rate: 30 mL/min (detector response will be reduced if nitrogen is substituted for helium carrier gas).

Injection volume: 0.8 µL

GC column: Six-ft x ¼-in OD (2 mm ID) glass GC column containing 10% UCON 50–HB–5100+2% KOH on 80/100 Chromosorb W–AW.

NPD conditions:

Hydrogen flow rate: 3 mL/min

Air flow rate: 50 mL/min

Detector temperature: 275 °C

3.5.2 *Chromatogram:* For an example of a typical chromatogram, see Figure 4.11 in OSHA Method 52.

3.5.3 Use a suitable method, such as electronic integration, to measure detector response.

3.5.4 Use an internal standard method to prepare the calibration curve with several standard solutions of different concentrations. Prepare the calibration curve daily. Program the integrator to report results in µg/mL.

3.5.5 Bracket sample concentrations with standards.

3.6 *Interferences (Analytical)*

3.6.1 Any compound with the same general retention time as the analytes and which also gives a detector response is a potential interference. Possible interferences should be reported to the laboratory with submitted samples by the industrial hygienist.

3.6.2 GC parameters (temperature, column, etc.) may be changed to circumvent interferences.

3.6.3 A useful means of structure designation is GC/MS. It is recommended this procedure be used to confirm samples whenever possible.

3.6.4 The coated adsorbent usually contains a very small amount of residual formaldehyde derivative (Section 4.8).

3.7 *Calculations:*

3.7.1 Results are obtained by use of calibration curves. Calibration curves are prepared by plotting detector response against concentration for each standard. The best line through the data points is determined by curve fitting.

3.7.2 The concentration, in µg/mL, for a particular sample is determined by comparing its detector response to the calibration curve. If either of the analytes is found on the backup section, it is added to the amount found on the front section. Blank corrections should be performed before adding the results together.

3.7.3 The acrolein and/or formaldehyde air concentration can be expressed using the following equation:

$mg/m^3 = (A)(B)/C$

where A = µg/mL from 3.7.2, B = desorption volume, and C = L of air sampled.

No desorption efficiency corrections are required.

3.7.4 The following equation can be used to convert results in mg/m^3 to ppm.

$ppm = (mg/m^3)(24.45)/MW$

where mg/m^3 = result from 3.7.3, 24.25 = molar volume of an ideal gas at 760 mm Hg and 25 °C, MW = molecular weight (30.0).

4. Backup Data

4.1 Backup data on detection limits, reliable quantitation limits, sensitivity and precision of the analytical method, breakthrough, desorption efficiency, storage, reproducibility, and generation of test atmospheres are available in OSHA Method 52, developed by the Organics Methods Evaluation Branch, OSHA Analytical Laboratory, Salt Lake City, Utah.

4.2 *Procedure to Coat XAD–2 Adsorbent with 2–HMP:*

4.2.1 *Apparatus:* Soxhlet extraction apparatus, rotary evaporation apparatus, vacuum dessicator, 1–L vacuum flask, 1–L round-bottomed evaporative flask, 1–L Erlenmeyer flask, 250-mL Buchner funnel with a coarse fritted disc, etc.

4.2.2 *Reagents:*

4.2.2.1 Methanol, isooctane, and toluene.

4.2.2.2 2-(Hydroxymethyl)piperidine.

4.2.2.3 Amberlite XAD–2 non-ionic polymeric adsorbent, 20 to 60 mesh, Aldrich Chemical XAD–2 was used in this evaluation.

4.2.3 *Procedure:* Weigh 125 g of crude XAD–2 adsorbent into a 1–L Erlenmeyer flask. Add about 200 mL of water to the flask and then swirl the mixture to wash the adsorbent. Discard any adsorbent that floats to the top of the water and then filter the mixture using a fritted Buchner funnel. Air dry the adsorbent for 2 minutes. Transfer the adsorbent back to the Erlenmeyer flask and then add about 200 mL of methanol to the flask. Swirl and then filter the mixture as before. Transfer the washed adsorbent back to the Erlenmeyer flask and then add about 200 mL of methanol to the flask. Swirl and then filter the mixture as before. Transfer the washed adsorbent to a 1–L round-bottomed evaporative flask, add 13 g of 2–HMP and then 200 mL of methanol, swirl the mixture and then allow it to stand for one hour. Remove the methanol at about 40 °C and reduced pressure using a rotary evaporation apparatus. Transfer the coated adsorbent to a suitable container and store it in a vacuum desiccator at room temperature overnight. Transfer the coated adsorbent to a Soxhlet extractor and then extract the material with toluene for about 24 hours. Discard the contaminated toluene, add methanol in its place and then continue the Soxhlet extraction for an additional 4 hours. Transfer the adsorbent to a weighted 1–L round-bottom evaporative flask and remove the methanol using the rotary evaporation apparatus. Determine the weight of the adsorbent and then add an amount of 2-HMP, which is 10% by weight of the adsorbent. Add 200 mL of methanol and then swirl the mixture. Allow the mixture to stand for one hour. Remove the methanol by rotary evaporation. Transfer the coated adsorbent to a suitable container and store it in a vacuum desiccator until all traces of solvents are gone. Typically, this will take 2–3 days. The coated adsorbent should be protected from contamination. XAD–2 adsorbent treated in this manner will probably not contain residual acrolein derivative. However, this adsorbent will often contain residual formaldehyde derivative levels of about 0.1 µg per 150 mg of adsorbent. If the blank values for a batch of coated adsorbent are too high, then the batch should be returned to the Soxhlet extractor, extracted with toluene again and then recoated. This process can be repeated until the desired blank levels are attained.

The coated adsorbent is now ready to be packed into sampling tubes. The sampling tubes should be stored in a sealed container to prevent contamination. Sampling tubes should be stored in the dark at room temperature. The sampling tubes should be segregated by coated adsorbent lot number. A sufficient amount of each lot number of coated adsorbent should be retained to prepare analytical standards for use with air samples from that lot number.

4.3 *A Procedure to Determine Formaldehyde by Acid Titration:* Standardize the 0.1 N HCl solution using sodium carbonate and methyl orange indicator.

Place 50 mL of 0.1 M sodium sulfite and three drops of thymophthalein indicator into a 250-mL Erlenmeyer flask. Titrate the contents of the flask to

a colorless endpoint with 0.1 N HCl (usually one or two drops is sufficient). Transfer 10 mL of the formaldehyde/methanol solution (prepared in 3.3.1) into the same flask and titrate the mixture with 0.1 N HCl, again, to a colorless endpoint. The formaldehyde concentration of the standard may be calculated by the following equation:

$$\text{Formaldehyde, mg/mL} = \frac{\text{acid titer} \times \text{acid normality} \times 30.0}{\text{mL of sample}}$$

This method is based on the quantitative liberation of sodium hydroxide when formaldehyde reacts with sodium sulfite to form the formaldehyde-bisulfite addition product. The volume of sample may be varied depending on the formaldehyde content but the solution to be titrated must contain excess sodium sulfite. Formaldehyde solutions containing substantial amounts of acid or base must be neutralized before analysis.

Appendix C to § 1910.1048—Medical Surveillance—Formaldehyde

I. Health Hazards

The occupational health hazards of formaldehyde are primarily due to its toxic effects after inhalation, after direct contact with the skin or eyes by formaldehyde in liquid or vapor form, and after ingestion.

II. Toxicology

A. Acute Effects of Exposure

1. *Inhalation (breathing):* Formaldehyde is highly irritating to the upper airways. The concentration of formaldehyde that is immediately dangerous to life and health is 100 ppm. Concentrations above 50 ppm can cause severe pulmonary reactions within minutes. These include pulmonary edema, pneumonia, and bronchial irritation which can result in death. Concentrations above 5 ppm readily cause lower airway irritation characterized by cough, chest tightness and wheezing. There is some controversy regarding whether formaldehyde gas is a pulmonary sensitizer which can cause occupational asthma in a previously normal individual. Formaldehyde can produce symptoms of bronchial asthma in humans. The mechanism may be either sensitization of the individual by exposure to formaldehyde or direct irritation by formaldehyde in persons with pre-existing asthma. Upper airway irritation is the most common respiratory effect reported by workers and can occur over a wide range of concentrations, most frequently above 1 ppm. However, airway irritation has occurred in some workers with exposures to formaldehyde as low as 0.1 ppm. Symptoms of upper airway irritation include dry or sore throat, itching and burning sensations of the nose, and nasal congestion. Tolerance to this level of exposure may develop within 1–2 hours. This tolerance can permit workers remaining in an environment of gradually increasing formaldehyde concentrations to be unaware of their increasingly hazardous exposure.

2. *Eye contact:* Concentrations of formaldehyde between 0.05 ppm and 0.5 ppm produce a sensation of irritation in the eyes with burning, itching, redness, and tearing. Increased rate of blinking and eye closure generally protects the eye from damage at these low levels, but these protective mechanisms may interfere with some workers' work abilities. Tolerance can occur in workers continuously exposed to concentrations of formaldehyde in this range. Accidental splash injuries of human eyes to aqueous solutions of formaldehyde (formalin) have resulted in a wide range of ocular injuries including corneal opacities and blindness. The severity of the reactions have been directly dependent on the concentration of formaldehyde in solution and the amount of time lapsed before emergency and medical intervention.

3. *Skin contact:* Exposure to formaldehyde solutions can cause irritation of the skin and allergic contact dermatitis. These skin diseases and disorders can occur at levels well below those encountered by many formaldehyde workers. Symptoms include erythema, edema, and vesiculation or hives. Exposure to liquid formalin or formaldehyde vapor can provoke skin reactions in sensitized individuals even when airborne concentrations of formaldehyde are well below 1 ppm.

4. *Ingestion:* Ingestion of as little as 30 ml of a 37 percent solution of formaldehyde (formalin) can result in death. Gastrointestinal toxicity after ingestion is most severe in the stomach and results in symptoms which can include nausea, vomiting, and servere abdominal pain. Diverse damage to other organ systems including the liver, kidney, spleen, pancreas, brain, and central nervous systems can occur from the acute response to ingestion of formaldehyde.

B. Chronic Effects of Exposure

Long term exposure to formaldehyde has been shown to be associated with an increased risk of cancer of the nose and accessory sinuses, nasopharyngeal and oropharyngeal cancer, and lung cancer in humans. Animal experiments provide conclusive evidence of a causal relationship between nasal cancer in rats and formaldehyde exposure. Concordant evidence of carcinogenicity includes DNA binding, genotoxicity in short-term tests, and cytotoxic changes in the cells of the target organ suggesting both preneoplastic changes and a dose-rate effect. Formaldehyde is a complete carcinogen and appears to exert an effect on at least two stages of the carcinogenic process.

III. Surveillance considerations

A. History

1. *Medical and occupational history:* Along with its acute irritative effects, formaldehyde can cause allergic sensitization and cancer. One of the goals of the work history should be to elicit information on any prior or additional exposure to formaldehyde in either the occupational or the non-occupational setting.

2. *Respiratory history:* As noted above, formaldehyde has recognized properties as an airway irritant and has been reported by some authors as a cause of occupational asthma. In addition, formaldehyde has been associated with cancer of the entire respiratory system of humans. For these reasons, it is appropriate to include a comprehensive review of the respiratory system in the medical history. Components of this history might include questions regarding dyspnea on exertion, shortness of breath, chronic airway complaints, hyperreactive airway disease, rhinitis, bronchitis, bronchiolitis, asthma, emphysema, respiratory allergic reaction, or other preexisting pulmonary disease.

In addition, generalized airway hypersensitivity can result from exposures to a single sensitizing agent. The examiner should, therefore, elicit any prior history of exposure to pulmonary irritants, and any short- or long-term effects of that exposure.

Smoking is known to decrease mucociliary clearance of materials deposited during respiration in the nose and upper airways. This may increase a worker's exposure to inhaled materials such as formaldehyde vapor. In addition, smoking is a potential confounding factor in the investigation of any chronic respiratory disease, including cancer. For these reasons, a

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complete smoking history should be obtained.

3. *Skin Disorders:* Because of the dermal irritant and sensitizing effects of formaldehyde, a history of skin disorders should be obtained. Such a history might include the existence of skin irritation, previously documented skin sensitivity, and other dermatologic disorders. Previous exposure to formaldehyde and other dermal sensitizers should be recorded.

4. *History of atopic or allergic diseases:* Since formaldehyde can cause allergic sensitization of the skin and airways, it might be useful to identify individuals with prior allergen sensitization. A history of atopic disease and allergies to formaldehyde or any other substances should also be obtained. It is not definitely known at this time whether atopic diseases and allergies to formaldehyde or any other substances should also be obtained. Also it is not definitely known at this time whether atopic individuals have a greater propensity to develop formaldehyde sensitivity than the general population, but identification of these individuals may be useful for ongoing surveillance.

5. *Use of disease questionnaires:* Comparison of the results from previous years with present results provides the best method for detecting a general deterioration in health when toxic signs and symptoms are measured subjectively. In this way recall bias does not affect the results of the analysis. Consequently, OSHA has determined that the findings of the medical and work histories should be kept in a standardized form for comparison of the year-to-year results.

B. Physical Examination

1. *Mucosa of eyes and airways:* Because of the irritant effects of formaldehyde, the examining physician should be alert to evidence of this irritation. A speculum examination of the nasal mucosa may be helpful in assessing possible irritation and cytotoxic changes, as may be indirect inspection of the posterior pharynx by mirror.

2. *Pulmonary system:* A conventional respiratory examination, including inspection of the thorax and auscultation and percussion of the lung fields should be performed as part of the periodic medical examination. Although routine pulmonary function testing is only required by the standard once every year for persons who are exposed over the TWA concentration limit, these tests have an obvious value in investigating possible respiratory dysfunction and should be used wherever deemed appropriate by the physician. In cases of alleged formaldehyde-induced airway disease, other possible causes of pulmonary disfunction (including exposures to other substances) should be ruled out. A chest radiograph may be useful in these circumstances. In cases of suspected airway hypersensitivity or allergy, it may be appropriate to use bronchial challenge testing with formaldehyde or methacholine to determine the nature of the disorder. Such testing should be performed by or under the supervision of a physician experienced in the procedures involved.

3. *Skin:* The physician should be alert to evidence of dermal irritation of sensitization, including reddening and inflammation, urticaria, blistering, scaling, formation of skin fissures, or other symptoms. Since the integrity of the skin barrier is compromised by other dermal diseases, the presence of such disease should be noted. Skin sensitivity testing carries with it some risk of inducing sensitivity, and therefore, skin testing for formaldehyde sensitivity should not be used as a routine screening test. Sensitivity testing may be indicated in the investigation of a suspected existing sensitivity. Guidelines for such testing have been prepared by the North American Contact Dermatitis Group.

C. Additional Examinations or Tests

The physician may deem it necessary to perform other medical examinations or tests as indicated. The standard provides a mechanism whereby these additional investigations are covered under the standard for occupational exposure to formaldehyde.

D. Emergencies

The examination of workers exposed in an emergency should be directed at the organ systems most likely to be affected. Much of the content of the examination will be similar to the periodic examination unless the patient has received a severe acute exposure requiring immediate attention to prevent serious consequences. If a severe overexposure requiring medical intervention or hospitalization has occurred, the physician must be alert to the possibility of delayed symptoms. Followup nonroutine examinations may be necessary to assure the patient's well-being.

E. Employer Obligations

The employer is required to provide the physician with the following information: A copy of this standard and appendices A, C, D, and E; a description of the affected employee's duties as they relate to his or her exposure concentration; an estimate of the employee's exposure including duration (*e.g.* 15 hr/wk, three 8-hour shifts, full-time); a description of any personal protective equipment, including respirators, used by the employee; and the results of any previous medical determinations for the affected employee related to formaldehyde exposure to the extent that this information is within the employer's control.

F. Physician's Obligations

The standard requires the employer to obtain a written statement from the physician. This statement must contain the physician's opinion as to whether the employee has any medical condition which would place him or her at increased risk of impaired health from exposure to formaldehyde or use of respirators, as appropriate. The physician must also state his opinion regarding any restrictions that should be placed on the employee's exposure to formaldehyde or upon the use of protective clothing or equipment such as respirators. If the employee wears a respirator as a result of his or her exposure to formaldehyde, the physician's opinion must also contain a statement regarding the suitability of the employee to wear the type of respirator assigned. Finally, the physician must inform the employer that the employee has been told the results of the medical examination and of any medical conditions which require further explanation or treatment. This written opinion is not to contain any information on specific findings or diagnoses unrelated to occupational exposure to formaldehyde.

The purpose in requiring the examining physician to supply the employer with a written opinion is to provide the employer with a medical basis to assist the employer in placing employees initially, in assuring that their health is not being inpaired by formaldehyde, and to assess the employee's ability to use any required protective equipment.

Appendix D to § 1910.1048—Nonmandatory Medical Disease Questionnaire

A. Identification

Plant Name _____
Date _____
Employee Name _____
S.S. # _____
Job Title _____
Birthdate: _____
Age: _____

Sex: _____
Height: _____
Weight: _____

B. Medical History

1. Have you ever been in the hospital as a patient?
   Yes ☐ No ☐
   If yes, what kind of problem were you having? _____
2. Have you ever had any kind of operation?
   Yes ☐ No ☐
   If yes, what kind? _____
3. Do you take any kind of medicine regularly?
   Yes ☐ No ☐
   If yes, what kind? _____
4. Are you allergic to any drugs, foods, or chemicals?
   Yes ☐ No ☐
   If yes, what kind of allergy is it? _____
   What causes the allergy? _____
5. Have you ever been told that you have asthma, hayfever, or sinusitis?
   Yes ☐ No ☐
6. Have you ever been told that you have emphysema, bronchitis, or any other respiratory problems?
   Yes ☐ No ☐
7. Have you ever been told you had hepatitis?
   Yes ☐ No ☐
8. Have you ever been told that you had cirrhosis?
   Yes ☐ No ☐
9. Have you ever been told that you had cancer?
   Yes ☐ No ☐
10. Have you ever had arthritis or joint pain?
    Yes ☐ No ☐
11. Have you ever been told that you had high blood pressure?
    Yes ☐ No ☐
12. Have you ever had a heart attack or heart trouble?
    Yes ☐ No ☐

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B–1. Medical History Update

1. Have you been in the hospital as a patient any time within the past year?
   Yes ☐ No ☐
   If so, for what condition? _____
2. Have you been under the care of a physician during the past year?
   Yes ☐ No ☐
   If so, for what condition? _____
3. Is there any change in your breathing since last year?
   Yes ☐ No ☐
   Better? _____
   Worse? _____
   No change? _____
   If change, do you know why? _____
4. Is your general health different this year from last year?
   Yes ☐ No ☐
   If different, in what way? _____
5. Have you in the past year or are you now taking any medication on a regular basis?
   Yes ☐ No ☐
   Name Rx _____
   Condition being treated _____

C. Occupational History

1. How long have you worked for your present employer?
2. What jobs have you held with this employer? Include job title and length of time in each job.
3. In each of these jobs, how many hours a day were you exposed to chemicals?
4. What chemicals have you worked with most of the time?
5. Have you ever noticed any type of skin rash you feel was related to your work?
   Yes ☐ No ☐
6. Have you ever noticed that any kind of chemical makes you cough?
   Yes ☐ No ☐
   Wheeze?
   Yes ☐ No ☐
   Become short of breath or cause your chest to become tight?
   Yes ☐ No ☐
7. Are you exposed to any dust or chemicals at home?
   Yes ☐ No ☐
   If yes, explain: _____
8. In other jobs, have you ever had exposure to:
   Wood dust?
   Yes ☐ No ☐
   Nickel of chromium?
   Yes ☐ No ☐
   Silica (foundry, sand blasting)?
   Yes ☐ No ☐
   Arsenic or asbestos?
   Yes ☐ No ☐
   Organic solvents?
   Yes ☐ No ☐
   Urethane foams?
   Yes ☐ No ☐

C–1. Occupational History Update

1. Are you working on the same job this year as you were last year?
   Yes ☐ No ☐
   If not, how has your job changed? _____
2. What chemicals are you exposed to on your job?
3. How many hours a day are you exposed to chemicals?
4. Have you noticed any skin rash within the past year you feel was related to your work?
   Yes ☐ No ☐
   If so, explain circumstances: _____
5. Have you noticed that any chemical makes you cough, be short of breath, or wheeze?
   Yes ☐ No ☐
   If so, can you identify it? _____

D. Miscellaneous

1. Do you smoke?
   Yes ☐ No ☐
   If so, how much and for how long? _____
   Pipe _____
   Cigars _____
   Cigarettes _____
2. Do you drink alcohol in any form?
   Yes ☐ No ☐
   If so, how much, how long, and how often?
3. Do you wear glasses or contact lenses?
   Yes ☐ No ☐
4. Do you get any physical exercise other than that required to do your job?
   Yes ☐ No ☐
   If so, explain: _____
5. Do you have any hobbies or "side jobs" that require you to use chemicals, such as furniture stripping, sand blasting, insulation or manufacture of urethane foam, furniture, etc?
   Yes ☐ No ☐
   If so, please describe, giving type of business or hobby, chemicals used and length of exposures.

E. Symptoms Questionnaire

1. Do you ever have any shortness of breath?
   Yes ☐ No ☐
   If yes, do you have to rest after climbing several flights of stairs?
   Yes ☐ No ☐
   If yes, if you walk on the level with people your own age, do you walk slower than they do?
   Yes ☐ No ☐
   If yes, if you walk slower than a normal pace, do you have to limit the distance that you walk?
   Yes ☐ No ☐
   If yes, do you have to stop and rest while bathing or dressing?
   Yes ☐ No ☐
2. Do you cough as much as three months out of the year?
   Yes ☐ No ☐

If yes, have you had this cough for more than two years?
Yes ☐ No ☐
If yes, do you ever cough anything up from chest?
Yes ☐ No ☐

3. Do you ever have a feeling of smothering, unable to take a deep breath, or tightness in your chest?
Yes ☐ No ☐
If yes, do you notice that this on any particular day of the week?
Yes ☐ No ☐
If yes, what day or the week?
Yes ☐ No ☐
If yes, do you notice that this occurs at any particular place?
Yes ☐ No ☐
If yes, do you notice that this is worse after you have returned to work after being off for several days?
Yes ☐ No ☐

4. Have you ever noticed any wheezing in your chest?
Yes ☐ No ☐
If yes, is this only with colds or other infections?
Yes ☐ No ☐
Is this caused by exposure to any kind of dust or other material?
Yes ☐ No ☐
If yes, what kind? _____

5. Have you noticed any burning, tearing, or redness of your eyes when you are at work?
Yes ☐ No ☐
If so, explain circumstances: _____

6. Have you noticed any sore or burning throat or itchy or burning nose when you are at work?
Yes ☐ No ☐
If so, explain circumstances: _____

7. Have you noticed any stuffiness or dryness of your nose?
Yes ☐ No ☐

8. Do you ever have swelling of the eyelids or face?
Yes ☐ No ☐

9. Have you ever been jaundiced?
Yes ☐ No ☐
If yes, was this accompanied by any pain?
Yes ☐ No ☐

10. Have you ever had a tendency to bruise easily or bleed excessively?
Yes ☐ No ☐

11. Do you have frequent headaches that are not relieved by aspirin or tylenol?
Yes ☐ No ☐
If yes, do they occur at any particular time of the day or week?
Yes ☐ No ☐
If yes, when do they occur? _____

12. Do you have frequent episodes of nervousness or irritability?
Yes ☐ No ☐

13. Do you tend to have trouble concentrating or remembering?
Yes ☐ No ☐

14. Do you ever feel dizzy, light-headed, excessively drowsy or like you have been drugged?
Yes ☐ No ☐

15. Does your vision ever become blurred?
Yes ☐ No ☐

16. Do you have numbness or tingling of the hands or feet or other parts of your body?
Yes ☐ No ☐

17. Have you ever had chronic weakness or fatigue?
Yes ☐ No ☐

18. Have you ever had any swelling of your feet or ankles to the point where you could not wear your shoes?
Yes ☐ No ☐

19. Are you bothered by heartburn or indigestion?
Yes ☐ No ☐

20. Do you ever have itching, dryness, or peeling and scaling of the hands?
Yes ☐ No ☐

21. Do you ever have a burning sensation in the hands, or reddening of the skin?
Yes ☐ No ☐

22. Do you ever have cracking or bleeding of the skin on your hands?
Yes ☐ No ☐

23. Are you under a physician's care?
Yes ☐ No ☐
If yes, for what are you being treated? _____

24. Do you have any physical complaints today?
Yes ☐ No ☐
If yes, explain? _____

25. Do you have other health conditions not covered by these questions?
Yes ☐ No ☐
If yes, explain: _____

Appendix E to § 1910.1048—Qualitative and Quantitative Fit Testing Procedures

I. FIT Test Protocols

Because exposure to formaldehyde can affect the employee's ability to detect common odorants, fit test results from the isoamyl acetate test must be augmented by results from either the saccharin or irritant smoke test.

A. The employer shall include the following provisions in the fit test procedures. These provisions apply to both qualitative fit testing (QLFT) and quantitative fit testing (QNFT).

1. The test subject shall be allowed to pick the most comfortable respirator from a selection including respirators of various sizes from different manufacturers. The selection shall include at least three sizes of elastomeric facepieces of the type of respirator that is to be tested, i.e., three sizes of half mask; or three sizes of full facepiece; and units from at least two manufacturers.

2. Prior to the selection process, the test subject shall be shown how to put on a respirator, how it should be positioned on the face, how to set strap tension and how to determine a comfortable fit. A mirror shall be available to assist the subject in evaluating the fit and positioning the respirator. This instruction may not constitute the subject's formal training on respirator use, as it is only a review.

3. The test subject shall be informed that he/she is being asked to select the respirator which provides the most comfortable fit. Each respirator represents a different size and shape, and if fitted and used properly, will provide adequate protection.

4. The test subject shall be instructed to hold each facepiece up to the face and eliminate those which obviously do not give a comfortable fit.

5. The more comfortable facepieces are noted; the most comfortable mask is donned and worn at least five minutes to assess comfort. Assistance in assessing comfort can be given by discussing the points in item 6 below. If the test subject is not familiar with using a particular respirator, the test subject shall be directed to don the mask several times and to adjust the straps each time to become adept at setting proper tension on the straps.

6. Assessment of comfort shall include reviewing the following points with the test subject and allowing the test subject adequate time to determine the comfort of the respirator:

(a) position of the mask on the nose.
(b) room for eye protection.
(c) room to talk.
(d) position of mask on face and cheeks.

7. The following criteria shall be used to help determine the adequacy of the respirator fit:

(a) chin properly placed;
(b) adequate strap tension, not overly tightened;
(c) fit across nose bridge;
(d) respirator of proper size to span distance from nose to chin;
(e) tendency of respirator to slip;
(f) self-observation in mirror to evaluate fit and respirator position.

8. The test subject shall conduct the negative and positive pressure fit checks as described below or ANSI Z88.2–1980. Before conducting the negative or positive pressure test, the subject shall be told to seat the mask on the face by

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moving the head from side-to-side and up and down slowly while taking in a few slow deep breaths. Another facepiece shall be selected and retested if the test subject fails the fit check tests.

(a) *Positive pressure test.* Close off the exhalation valve and exhale gently onto the facepiece. The face fit is considered satisfactory if a slight positive pressure can be built up inside the facepiece without any evidence of outward leakage of air at the seal. For most respirators this method of leak testing requires the wearer to first remove the exhalation valve cover before closing off the exhalation valve and then carefully replacing it after the test.

(b) *Negative pressure test.* Close off the inlet opening of the canister or cartridge(s) by covering with the palm of the hand(s) or by replacing the filter seal(s), inhale gently so that the facepiece collapses slightly, and hold the breath for ten seconds. If the facepiece remains in its slightly collapsed condition and no inward leakage of air is detected, the tightness of the respirator is considered satisfactory.

9. The test shall not be conducted if there is any hair growth between the skin and the facepiece sealing surface, such as stubble beard growth, beard, or long sideburns which cross the respirator sealing surface. Any type of apparel which interferes with a satisfactory fit shall be altered or removed.

10. If a test subject exhibits difficulty in breathing during the tests, she or he shall be referred to a physician trained in respiratory disease or pulmonary medicine to determine whether the test subject can wear a respirator while performing her or his duties.

11. The test subject shall be given the opportunity to wear the successfully fitted respirator for a period of two weeks. If at any time during this period the respirator becomes uncomfortable, the test subject shall be given the opportunity to select a different facepiece and to be retested.

12. The employer shall certify that a successful fit test has been administered to the employee. The certification shall include the following information:

(a) Name of employee;

(b) Type, brand and size of respirator; and

(c) Date of test;

Where QNFT is used, the fit factor, trip chart, or other recording of the results of the test, shall be retained with the certification. The certification shall be maintained until the next fit test is administered.

13. Exercise regimen. Prior to the commencement of the fit test, the test subject shall be given a description of the fit test and the test subject's responsibilities during the test procedure.

The description of the process shall include a description of the test exercises that the subject will be performing. The respirator to be tested shall be worn for at least 5 minutes before the start of the fit test.

14. Test Exercises. The test subject shall perform exercises, in the test environment, in the manner described below:

(a) *Normal breathing.* In a normal standing position, without talking, the subject shall breathe normally.

(b) *Deep breathing.* In a normal standing position, the subject shall breathe slowly and deeply, taking caution so as to not hyperventilate.

(c) *Turning head side to side.* Standing in place, the subject shall slowly turn his/her head from side to side between the extreme positions on each side. The head shall be held at each extreme momentarily so the subject can inhale at each side.

(d) *Moving head up and down.* Standing in place, the subject shall slowly move his/her head up and down. The subject shall be instructed to inhale in the up position (i.e., when looking toward the ceiling).

(e) *Talking.* The subject shall talk out loud slowly and loud enough so as to be heard clearly by the test conductor. The subject can read from a prepared text such as the Rainbow Passage, count backward from 100, or recite a memorized poem or song.

(f) *Grimace.* The test subject shall grimace by smiling or frowning.

(g) *Bending over.* The test subject shall bend at the waist as if he/she were to touch his/her toes. Jogging in place shall be substituted for this exercise in those test environments such as shroud type QNFT units which prohibit bending at the waist.

(h) *Normal breathing.* Same as exercise 1.

Each test exercise shall be performed for one minute except for the grimace exercise which shall be performed for 15 seconds.

The test subject shall be questioned by the test conductor regarding the comfort of the respirator upon completion of the protocol. If it has become uncomfortable, another model of respirator shall be tried.

B. Qualitative Fit Test (QLFT) Protocols

1. *General.* (a) The employer shall assign specific individuals who shall assume full responsibility for implementing the respirator qualitative fit test program.

(b) The employer shall ensure that persons administering QLFT are able to prepare test solutions, calibrate equipment and perform tests properly, recognize invalid tests, and assure that tese equipment is in proper working order.

(c) The employer shall assure the QLFT equipment is kept clean and well maintained so as to operate at the parameters for which it was designed.

2. *Isoamyl Acetate Protocol*—(a) *Odor threshold screening.* The odor threshold screening test, performed without wearing a respirator, is intended to determine if the individual tested can detect the odor of isoamyl acetate.

(1) Three 1-liter glass jars with metal lids are required.

(2) Odor free water (e.g., distilled or spring water) at approximately 25 degrees C shall be used for the solutions.

(3) The isoamyl acetate (IAA) (also known at isopentyl acetate) stock solution is prepared by adding 1 cc of pure IAA to 800 cc of odor free water in a 1 liter jar and shaking for 30 seconds. A new solution shall be prepared at least weekly.

(4) The screening test shall be conducted in a room separate from the room used for actual fit testing. The two rooms shall be well ventilated but shall not be connected to the same recirculating ventilation system.

(5) The odor test solution is prepared in a second jar by placing 0.4 cc of the stock solution into 500 cc of odor free water using a clear dropper or pipette. The solution shall be shaken for 30 seconds and allowed to stand for two to three minutes so that the IAA concentration above the liquid may reach equilibrium. This solution shall be used for only one day.

(6) A test blank shall be prepared in a third jar by adding 500 cc of odor free water.

(7) The odor test and test blank jars shall be labeled 1 and 2 for jar identification. Labels shall be placed on the lids so they can be periodically peeled, dried off and switched to maintain the integrity of the test.

(8) The following instruction shall be typed on a card and placed on the table in front of the two jars (i.e., 1 and 2): "The purpose of this test is to determine if you can smell banana oil at a low concentration. The two bottles in front of you contain water. One of these bottles also contain a small amount of banana oil. Be sure the covered are on tight, then shake each bottle for two seconds. Unscrew the lid of each bottle, one at a time, and sniff at the mouth of

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the bottle. Indicate to the test conductor which bottle contains banana oil."

(9) The mixtures used in the IAA ordor detection test shall be prepared in an area separate from where the test is performed, in order to prevent olfactory fatigue in the subject.

(10) If the test subject is unable to correctly identify the jar containing the odor test solution, the IAA qualitative fit test shall not be performed.

(11) If the test subject correctly identifies the jar containing the odor test solution, the test subject may proceed to respirator selection and fit testing.

(b) *Isoamyl acetate fit test.* (1) The fit test chamber shall be similar to a clear 55-gallon drum liner suspended inverted over a 2-foot diameter frame so that the top of the chamber is about 6 inches above the test subject's head. The inside top center of the chamber shall have a small hook attached.

(2) Each respirator used for the fitting and fit testing shall be equipped with organic vapor cartridges or offer protection against organic vapors. The cartridges or masks shall be changed at least weekly.

(3) After selecting, donning, and properly adjusting a respirator, the test subject shall ware it to the fit testing room. This room shall be separate from the room used for odor threshold screening and respirator selection, and shall be well ventilated, as by an exhaust fan or lab hood, to prevent general room contamination.

(4) A copy of the test exercises and any prepared text from which the subject is to read shall be taped to the inside of the test chamber.

(5) Upon entering the test chamber, the test subject shall be given a 6-inch by 5-inch piece of paper towel, or other porous, absorbent, single-ply material, folded in half and wetted with 0.75 cc of pure IAA. The test subject shall hang the wet towel on the hook at the top of the chamber.

(6) Allow two minutes for the IAA test concentration to stabilize before starting the fit test exercises. This would be an appropriate time to talk with the test subject; to explain the fit test, the importance of his/her cooperation, and the purpose for the head exercises; or to demonstrate some of the exercises.

(7) If at any time during the test, the subject detects the banana like odor of IAA, the test has failed. The subject shall quickly exit from the test chamber and leave the test area to avoid olfactory fatigue.

(8) If the test has failed, the subject shall return to the selection room and remove the respirator, repeat the odor sensitivity test, select and put on another respirator, return to the test chamber and again begin the procedure described in (1) through (7) above. The process continues until a respirator that fits well has been found. Should the odor sensitivity test be failed, the subject shall wait about 5 minutes before retesting. Odor sensitivity will usually have returned by this time.

(9) When a respirator is found that passes the test, its efficiency shall be demonstrated for the subject by having the subject break the face seal and take a breath before exiting the chamber.

(10) When the test subject leaves the chamber, the subject shall remove the saturated towel and return it to the person conducting the test. To keep the test area from becoming contaminated, the used towels shall be kept in a self sealing bag so there is no significant IAA concentration build-up in the test chamber during subsequent tests.

3. *Saccharin Solution Aerosol Protocol.* The saccharin solution aerosol QLFT protocol is the only currently available, validated test protocol for use with particulate disposable dust respirators not equipped with high-efficiency filters. The entire screening and testing procedure shall be explained to the test subject prior to the conduct of the screening test.

(a) *Taste threshold screening.* The saccharin taste threshold screening, performed without wearing a respirator, is intended to determine whether the individual being tested can detect the taste of saccharin.

(1) Threshold screening as well as fit testing subjects shall wear an enclosure about the head and shoulders that is approximately 12 inches in diameter by 14 inches tall with at least the front portion clear and that allows free movements of the head when a respirator is worn. An enclosure substantially similar to the 3M hood assembly, parts # FT 14 and # FT 15 combined, is adequate.

(2) The test enclosure shall have a ¾-inch hole in front of the test subject's nose and mouth area to accommodate the nebulizer nozzle.

(3) The test subject shall don the test enclosure. Throughout the threshold screening test, the test subject shall breathe through his/her wide open mouth with tongue extended.

(4) Using a DeVilbiss Model 40 Inhalation Medication Nebulizer the test conductor shall spray the *threshold check solution* into the enclosure. This nebulizer shall be clearly marked to distinguish it from the fit test solution nebulizer

(5) The *threshold check solution* consists of 0.83 grams of sodium saccharin USP in 1 cc of warm water. It can be prepared by putting 1 cc of the fit test solution (see (b)(5) below) in 100 cc of distilled water.

(6) To produce the aerosol, the nebulizer bulb is firmly squeezed so that it collapses completely, then released and allowed to fully expand.

(7) Ten squeezes are repeated rapidly and then the test subject is asked whether the saccharin can be tasted.

(8) If the first response is negative, ten more squeezes are repeated rapidly and the test subject is again asked whether the saccharin is tasted.

(9) If the second response is negative, ten more squeezes are repeated rapidly and the test subject is again asked whether the saccharin is tasted.

(10) The test conductor will take note of the number of squeezes required to solicit a taste response.

(11) If the saccharin is not tasted after 30 squeezes (step 10), the test subject may not perform the saccharin fit test.

(12) If a taste response is elicited, the test subject shall be asked to take note of the taste for reference in the fit test.

(13) Correct use of the nebulizer means that approximately 1 cc of liquid is used at a time in the nebulizer body.

(14) The nebulizer shall be thoroughly rinsed in water, shaken dry, and refilled at least each morning and afternoon or at least every four hours.

(b) *Saccharin solution aerosol fit test procedure.* (1) The test subject may not eat, drink (except plain water), or chew gum for 15 minutes before the test.

(2) The fit test uses the same enclosure described in (a) above.

(3) The test subject shall don the enclosure while wearing the respirator selected in section (a) above. The respirator shall be properly adjusted and equipped with a particular filter(s).

(4) A second DeVilbiss Model 40 Inhalation Medication Nebulizer is used to spray the fit test solution into the enclosure. This nebulizer shall be clearly marked to distinguish it from the screening test solution nebulizer.

(5) The fit test solution is prepared by adding 83 grams of sodium saccharin to 100 cc of warm water.

(6) As before, the test subject shall breathe through the open mouth with tongue extended.

(7) The nebulizer is inserted into the hole in the front of the enclosure and the fit test solution is sprayed into the enclosure using the same number of squeezes required to elicit a taste response in the screening test.

(8) After generating the aerosol the test subject shall be instructed to perform the exercises in section I. A. 14 above.

(9) Every 30 seconds the aerosol concentration shall be replenished using

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one half the number of squeeezes as initially.

(10) The test subject shall indicate to the test conductor if any time during the fit test the taste of saccharin is detected.

(11) If the taste of saccharin is detected, the fit is deemed unsatisfactory and a different respirator shall be tried.

4. *Irritant Fume Protocol.* (a) The respirator to be tested shall be equipped with high-efficiency particulate air (HEPA) filters.

(b) The test subject shall be allowed to smell a weak concentration of the irritant smoke before the respirator is donned to become familiar with its characteristric odor.

(c) Break both ends of a ventilation smoke tube containing stannic oxychloride, such as the MSA part No. 5645, or equivalent. Attach one end of the smoke tube to a low flow air pump set to deliver 200 milliliters per minute.

(d) If a half-mask is being fitted, advise the test subject that the smoke can be irritating to the eyes and instruct the subject to keep his/her eyes closed while the test is performed.

(e) The test conductor shall direct the stream of irritant smoke from the smoke tube towards the face seal area of the test subject. He/She shall begin at least 12 inches from the facepiece and gradually move to within one inch, moving around the whole perimeter of the mask.

(f) The exercises identified in section I. A. 14 above shall be performed by the test subject while the respirator seal is being challenged by the smoke.

(g) Each test subject passing the smoke test without evidence of a response shall be given a sensitivity check of the smoke from the same tube once the respirator has been removed to determine whether he/she reacts to the smoke. Failure to evoke a response shall void the fit test.

(h) The fit test shall be performed in a location with exhaust ventilation sufficient to prevent general contamination of the testing area by the test agent.

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C. Quantitative Fit Test (QNFT) Protocol

1. *General.* (a) The employer shall assign specific individuals who shall assume full responsibility for implementing the respirator quantitative fit test program.

(b) The employer shall ensure that persons administering QNFT are able to calibrate equipment and perform tests properly, recognize invalid tests, calculate fit factors properly and assure that test equipment is in proper working order.

(c) The employer shall assure that QNFT equipment is kept clean and well maintained so as to operate at the parameters for which it was designed.

2. *Definitions.* (a) Quantitative fit test. The test is performed in a test chamber. The normal air-purifying element of the respirator is replaced by a high-efficiency particulate air (HEPA) filter in the case of particulate QNFT aerosols or a sorbent offering contaminant penetration protection equivalent to high-efficiency filters where the QNFT test agency is a gas or vapor.

(b) Challenge agent means the aerosol, gas or vapor introduced into a test chamber so that its concentration inside and outside the respirator may be measured.

(c) Test subject means the person wearing the respirator for quantitative fit testing.

(d) Normal standing position means standing erect and straight with arms down along the sides and looking straight ahead.

(e) Maximum peak penetration method means the method of determing test agent penetration in the respirator as determined by strip chart recordings of the test. The highest peak penetration for a given exercise is taken to be representative of average penetration into the respirator for that exercise.

(f) Average peak penetration method means the method of determining test agent penetration into the respirator utilizing a strip chart recorder, integrator, or computer. The agent penetration is determined by an average of the peak heights on the graph or by computer integration, for each exercise except the grimace exercise. Integrators or computers which calculate the actual test agent penetration into the respirator for each exercise will also be considered to meet the requirements of the average peak penetration method.

(g) "Fit Factor" means the ratio of challenge agent concentration outside with respect to the inside of a respirator inlet covering (facepiece or enclosure).

3. *Apparatus.* (a) Instrumentation. Aerosol generation, dilution, and measurement systems using corn oil or sodium chloride as test aerosols shall be used for quantitiative fit testing.

(b) Test chamber. The test chamber shall be large enough to permit all test subjects to perform freely all required exercises without disturbing the challenge agent concentration or the measurement apparatus. The test chamber shall be equipped and constructed so that the challenge agent is effectively isolated from the ambient air, yet uniform in concentration throughout the chamber.

(c) When testing air-purifying respirators, the normal filter or cartridge element shall be replaced with a high-efficiency particulate filter supplied by the same manufacturer.

(d) The sampling instrument shall be selected so that a strip chart record may be made of the test showing the rise and fall of the challenge agent concentration with each inspiration and expiration at fit factors of at least 2,000. Integrators or computers which integrate the amount of test agent penetration leakage into the respirator for each exercise may be used provided a record of the readings is made.

(e) The combination of substitute air-purifying elements, challenge agent and challenge agent concentration in the test chamber shall be such that the test subject is not exposed in excess of an established exposure limit for the challenge agent at any time during the testing process.

(f) The sampling port on the test specimen respirator shall be placed and constructed so that no leakage occurs around the port (e.g., where the respirator is probed), a free air flow is allowed into the sampling line at all times and so that there is no interference with the fit or performance of the respirator.

(g) The test chamber and test set up shall permit the person administering the test to observe the test subject inside the chamber during the test.

(h) The equipment generating the challenge atmosphere shall maintain the concentration of challenge agent inside the test chamber constant to within a 10 percent variation for the duration of the test.

(i) The time lag (interval between an event and the recording of the event on the strip chart or computer or integrator) shall be kept to a minimum. There shall be a clear association between the occurrence of an event inside the test chamber and its being recorded.

(j) The sampling line tubing for the test chamber atmosphere and for the respirator sampling port shall be of equal diameter and of the same material. The length of the two lines shall be equal.

(k) The exhaust flow from the test chamber shall pass through a high-effciency filter before release.

(l) When sodium chloride aerosol is used, the relative humidity inside the test chamber shall not exceed 50 percent.

(m) The limitations of instrument detection shall be taken into account when determining the fit factor.

(n) Test respirators shall be maintained in proper working order and

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inspected for deficiencies sush as cracks, missing valves and gaskets, etc.

4. *Procedural Requirements.* (a) When performing the initial positive or negative pressure test the sampling line shall be crimped closed in order to avoid air pressure leakage during either of these tests.

(b) An abbreviated screening isoamyl acetate test or irritant fume test may be utilized in order to quickly identify poor fitting respirators which passed the positive and/or negative pressure test and thus reduce the amount of QNFT time. When performing a screening isoamyl acetate test, combination high-efficiency organic vapor cartridges/canisters shall be used.

(c) A reasonably stable challenge agent concentration shall be measured in the test chamber prior to testing. For canopy or shower curtain type of test units the determination of the challenge agent stability may be established after the test subject has entered the test environment.

(d) Immediately after the subject enters the test chamber, the challenge agent concentration inside the respirator shall be measured to ensure that the peak penetration does not exceed 5 percent for a half mask or 1 percent for a full facepiece respirator.

(e) A stable challenge concentration shall be obtained prior to the actual start of testing.

(f) Respirator restraining straps shall not be overtightened for testing. The straps shall be adjusted by the wearer without assistance from other persons to give a reasonable comfortable fit typical of normal use.

(g) The test shall be terminated whenever any single peak penetration exceeds 5 percent for half masks and 1 percent for full facepiece respirators. The test subject shall be refitted and retested. If two of the three required tests are terminated, the fit shall be deemed inadequate.

(h) In order to successfully complete a QNFT, three successful fit tests are required. The results of each of the three independent fit tests must exceed the minimum fit factor needed for the class of respirator (e.g., half mask respirator, full facepiece respirator).

(i) Calculation of fit factors.

(1) The fit factor shall be determined for the quantitative fit test by taking the ratio of the average chamber concentration to the concentration inside the respirator.

(2) The average test chambe concentration is the arithmetic average of the test chamber concentration at the beginning and of the end of the test.

(3) The concentration of the challenge agent inside the respirator shall be determined by one of the following methods:

(i) Average peak concentration

(ii) Maximum peak concentration

(iii) Integration by calculation of the area under the individual peak for each exercise. This includes computerized integration.

(j) Interpretation of test results. The fit factor established by the quantitative fit testing shall be the lowest of the three fit factor values calculated from the three required fit tests.

(k) The test subject shall not be permitted to wear a half mask, or full facepiece respirator unless a minimum fit factor equivalent to at least 10 times the hazardous exposure level is obtained

(l) Filters used for quantitative fit testing shall be replaced at least weekly, or whenever increased breathing resistance is encountered, or when the test agent has altered the integrity of the filter media. Organic vapor cartridges/canisters shall be replaced daily (when used) or sooner if there is any indication of breakthrough by a test agent.

PART 1926—[AMENDED]

Subpart D—[Amended]

6. The authority citation for Subpart D of Part 1926 continues to read as follows:

Authority: Secs. 4, 6, 8 Occupational Safety and Health Act of 1970, 29 U.S.C. 653, 655, 657; sec. 107, Contract Work Hours and Safety Standards Act (Construction Safety Act), 40 U.S.C. 333, and Secretary of Labor's Orders 12–71 (36 FR 8754), 8–76 (41 FR 25059), or 9–83 (48 FR 35736), as applicable. Sections 1926.55(c) and 1926.58 also issued under 29 CFR Part 1911.

7. A new paragraph (d) is added to § 1926.55 to read as follows:

§ 1926.55 Gases, vapors, fumes, dusts and mists.

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(d) Paragraphs (a) and (b) of this section do not apply to the exposure of employees to formaldehyde. Whenever any employee is exposed to formaldehyde, the requirements of § 1910.1048 of this title shall apply.

[FR Doc. 87–27329 Filed 12–2–87; 12:00 pm]

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Appendix A to Section 1910.1050 — Substance Data Sheet, for 4,4'—Methylenedianiline

I. Substance Identification

A. Substance: Methylenedianiline (MDA)

B. Permissible Exposure:

1. Airborne: Ten parts per billion parts of air (10 ppb), time-weighted average (TWA) for an 8-hour workday and an action level of five parts per billion parts of air (5 ppb).

2. Dermal: Eye contact and skin contact with MDA are not permitted.

C. Appearance and odor: White to tan solid; amine odor

II. Health Hazard Data

A. Ways in which MDA affects your health. MDA can affect your health if you inhale, it, or if it comes in contact with your skin or eyes. MDA is also harmful if you happen to swallow it. Do not get MDA in eyes, on skin, or on clothing.

B. Effects of overexposure.

1. Short-term (acute) overexposure: Overexposure to MDA may produce fever, chills, loss of appetite, vomiting, jaundice. Contact may irritate skin, eyes and mucous membranes. Sensitization may occur.

2. Long-term (chronic) exposure. Repeated or prolonged exposure to MDA, even at relatively low concentrations, may cause cancer. In addition, damage to the liver, kidneys, blood, and spleen may occur with long term exposure.

3. Reporting signs and symptoms: You should inform your employer if you develop any signs or symptoms which you suspect are caused by exposure to MDA including yellow staining of the skin.

III. Protective Clothing and Equipment

A. Respirators. Respirators are required for those operations in which engineering controls or work practice controls are not adequate or feasible to reduce exposure to the permissible limit. If respirators are worn, they must have the joint Mine Safety and Health Administration and National Institute for Occupational Safety and Health (NIOSH) seal of approval, and cartridges or canisters must be replaced as necessary to maintain the effectiveness of the respirator. If you experience difficulty breathing while wearing a respirator, you may request a positive pressure respirator from your employer. You must be thoroughly trained to use the assigned respirator, and the training will be provided by your employer.

MDA does not have a detectable odor except at levels well above the permissible exposure limits. Do not depend on odor to warn you when a respirator canister is exhausted. If you can smell MDA while wearing a respirator, proceed immediately to fresh air. If you experience difficulty breathing while wearing a respirator, tell your employer.

B. Protective Clothing. You may be required to wear coveralls, aprons, gloves, face shields, or other appropriate protective clothing to prevent skin contact with MDA. Where protective clothing is required, your employer is required to provide clean garments to you, as necessary, to assure that the clothing protects you adequately. Replace or repair impervious clothing that has developed leaks.

MDA should never be allowed to remain on the skin. Clothing and shoes which are not impervious to MDA should not be allowed to become contaminated with MDA, and if they do, the clothing and shoes should be promptly removed and decontaminated. The clothing should be laundered to remove MDA or discarded. Once MDA penetrates shoes or other leather articles, they should not be worn again.

C. Eye protection. You must wear splash-proof safety goggles in areas where liquid MDA may contact your eyes. Contact lenses should not be worn in areas where eye contact with MDA can occur. In addition, you must wear a face shield if your face could be splashed with MDA liquid.

IV. Emergency and First Aid Procedures

A. Eye and face exposure. If MDA is splashed into the eyes, wash the eyes for at least 15 minutes. See a doctor as soon as possible.

B. Skin exposure. If MDA is spilled on your clothing or skin, remove the contaminated clothing and wash the exposed skin with large amounts of soap and water immediately. Wash contaminated clothing before you wear it again.

C. Breathing. If you or any other person breathes in large amounts of MDA, get the exposed person to fresh air at once. Apply artificial respiration if breathing has stopped. Call for medical assistance or a doctor as soon as possible. Never enter any vessel or confined space where the MDA concentration might be high without proper safety equipment and at least one other person present who will stay outside. A life line should be used.

D. Swallowing. If MDA has been swallowed and the patient is conscious, do not induce vomiting. Call for medical assistance or a doctor immediately.

V. Medical Requirements

If you are exposed to MDA at a concentration at or above the action level for more than 30 days per year, or exposed to liquid mixtures more than 15 days per year, your employer is required to provide a medical examination, including a medical history and laboratory tests, within 60 days of the effective date of this standard and annually thereafter. These tests shall be provided without cost to you. In addition, if you are accidentally exposed to MDA (either by ingestion, inhalation, or skin/eye contact) under conditions known or suspected to constitute toxic exposure to MDA, your employer is required to make special examinations and tests available to you.

VI. Observation of Monitoring

Your employer is required to perform measurements that are representative of your exposure to MDA and you or your designated representative are entitled to observe the monitoring procedure. You are entitled to observe the steps taken in the measurement procedure and to record the results obtained. When the monitoring procedure is taking place in an area where respirators or personal protective clothing and equipment are required to be worn, you and your representative must also be provided with, and must wear, the protective clothing and equipment.

VII. Access to Records

You or your representative are entitled to see the records of measurements of your exposure to MDA upon written request to your employer. Your medical examination records can be furnished to your physician or designated representative upon request by you to your employer.

VIII. Precautions for Safe Use, Handling and Storage

A. Material is combustible. Avoid strong acids and their anhydrides. Avoid strong oxidants. Consult supervisor for disposal requirements.

B. Emergency clean-up. Wear self-contained breathing apparatus and fully clothe the body in the appropriate personal protective clothing and equipment.

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Appendix B to Section 1910.1050—Substance Technical Guidelines, MDA

I. identification

A. Substance identification.

1. Synonyms: CAS No. 101-77-9. 4,4'-methylenedianiline; 4,4'-methylenebisaniline; methylenedianiline: dianilinomethane.

2. Formula: $C_{13}H_{14}N_2$

II. Physical Data

1. Appearance and Odor. White to tan solid; amine odor

2. Molecular Weight: 198.26

3. Boiling Point: 398-399 degrees C at 760 mm Hg

4. Melting Point: 88-93 degrees C (190-100 degrees F)

5. Vapor Pressure: 9 mm Hg at 232 degrees C

6. Evaporation Rate (n-butyl acetate = 1): Negligible

7. Vapor Density (Air=1): Not Applicable

8. Volatile Fraction by Weight: Negligible

9. Specific Gravity (Water=1); Slight

10. Heat of Combustion: -8.40 kcal/g

11. Solubility in Water: Slightly soluble in cold water, very soluble in alcohol, benzene, ether, and many organic solvents.

III. Fire, Explosion, and Reactivity Hazard Data

1. Flash Point: 190 degrees C (374 degrees F) Setaflash closed cup

2. Flash Point: 226 degrees C (439 degrees F) Cleveland open cup

3. Extinguishing Media: Water spray; Dry Chemical; Carbon dioxide.

4. Special Fire Fighting Procedures: Wear self-contained breathing apparatus and protective clothing to prevent contact with skin and eyes.

5. Unusual Fire and Explosion Hazards: Fire or excessive heat may cause production of hazardous decomposition products.

IV. Reactivity Data

1. Stability: Stable

2. Incompatibility: Strong oxidizers

3. Hazardous Decomposition Products: As with any other organic material, combustion may produce carbon monoxide. Oxides of nitrogen may also be present.

4. Hazardous Polymerization: Will not occur.

V. Spill and Leak Procedures

1. Sweep material onto paper and place in fiber carton

2. Package appropriately for safe feed to an incinerator or dissolve in compatible waste solvents prior to incineration.

3. Dispose of in an approved incinerator equipped with afterburner and scrubber or contract with licensed chemical waste disposal service.

4. Discharge treatment or disposal may be subject to federal, state, or local laws.

5. Wear appropriate personal protective equipment.

VI. Special Storage and Handling Precautions

A. High exposure to MDA can occur when transferring the substance from one container to another. Such operations should be well ventilated and good work practices must be established to avoid spills.

B. Pure MDA is a solid with a low vapor pressure. Grinding or heating operations increase the potential for exposure.

C. Store away from oxidizing materials.

D. Employers shall advise employees of all areas and operations where exposure to MDA could occur.

VII. Housekeeping and Hygiene Facilities

A. The workplace should be kept clean, orderly, and in a sanitary condition.

The employer should institute a leak and spill detection program for operations involving MDA in order to detect sources of fugitive MDA emissions.

B. Adequate washing facilities with hot and cold water are to be provided and maintained in a sanitary condition. Suitable cleansing agents should also be provided to assure the effective removal of MDA from the skin.

VIII. Common Operations

Common operations in which exposure to MDA is likely to occur include the following: Manufacture of MDA; Manufacture of Methylene diisocyanate; Curing agent for epoxy resin structures; Wire coating operations; and filament winding.

Appendix C to Section 1910.1050—Medical Surveillance Guidelines for MDA

I. Route of Entry

Inhalation; skin absorption; ingestion. MDA can be inhaled, absorbed through the skin, or ingested.

II. Toxicology

MDA is a suspect carcinogen in humans. There are several reports of liver disease in humans and animals resulting from acute exposure to MDA. A well documented case of an acute cardiomyopathy secondary to exposure to MDA is on record. Numerous human cases of hepatitis secondary to MDA are known. Upon direct contact MDA may also cause damage to the eyes. Dermatitis and skin sensitization have been observed. Almost all forms of acute environmental hepatic injury in humans involve the hepatic parenchyma and produce hepatocellular jaundice. This agent produces intrahepatic cholestatic. The clinical picture consists of cholestatic jaundice, preceded or accompanied by abdominal pain, fever, and chills. Onset in about 60% of all observed cases is abrupt with severe abdominal pain. In about 30% of observed cases, the illness presented and evolved more slowly and less dramatically, with only slight abdominal pain. In about 10% of the cases only jaundice was evident. The cholestatic nature of the jaundice is evident in the prominence of itching, the histologic predominance of bile stasis, and portal inflammatory infiltration, accompanied by only slight parenchymal injury in most cases, and by the moderately elevated transaminase values. Acute, high doses, however, have been known to cause hepatocellular damage resulting in elevated SGPT, SGOT, alkaline phosphatase and bilirubin.

Absorption through the skin is rapid. MDA is metabolized and excreted over a 48-hour period. Direct contact may be irritating to the skin, causing dermatitis. Also MDA which is deposited on the skin is not thoroughly removed through washing.

MDA may cause bladder cancer in humans. Animal data supporting this assumption is not available nor is conclusive human data. However, human data collected on workers at a helicopter manufacturing facility where MDA is used suggests a higher incidence of bladder cancer among exposed workers.

III. Signs and Symptoms

Skin may become yellow from contact with MDA

Repeated or prolonged contact with MDA may result in recurring dermatitis (red itchy, cracked skin) and eye irritation. Inhalation, ingestion or absorption through the skin at high concentrations may result in hepatitis, causing symptoms such as fever and chills, nausea and vomiting, dark urine, anorexia, rash, right upper quadrant pain and jaundice. Corneal burns may occur when MDA is splashed in the eyes.

IV. Treatment of Acute Toxic Effects/ Emergency Situation

If MDA gets into the eyes, immediately wash eyes with large amounts of water. If MDA is splashed on the skin, immediately wash contaminated skin with mild soap or detergent. Employee should be removed from exposure and given proper medical treatment. Medical tests required under the emergency section of the medical surveillance section (M)(4) must be conducted.

If the chemical is swallowed do not induce vomiting but remove by gastric lavage.

Appendix D to Section 1910.1050—Sampling and Analytical Methods for MDA Monitoring and Measurement Procedures.

Measurements taken for the purpose of determine employee exposure to MDA are best taken so that the representative average 8-hour exposure may be determined from a single 8-hour sample or two (2) 4-hour samples. Short-time interval samples (or grab samples) may also be used to determine average exposure level if a minimum of five measurements are taken in a random manner over the 8-hour work shift. Random sampling means that any portion of the work shift has the same chance of being sampled as any other. The arithmetic average of all such random samples taken on one work shift is an estimate of an employee's average level of exposure for that work shift. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

There are a number of methods available for monitoring employee exposures to MDA. The method OSHA currently uses is included below.

The employer, however, has the obligation of selecting any monitoring method which meets the accuracy and precision requirements of the standard under his unique field conditions. The standard requires that the method of monitoring must have an accuracy, to a 95 percent confidence level, of not less than plus or minus 25 percent for the select PEL.

OSHA Methodology
Sampling Procedure
Apparatus

Samples are collected by use of a personal sampling pump that can be calibrated within ± 5% of the recommended flow rate with the sampling filter in line.

Samples are collected on 37 mm Gelman type A/E glass fiber filters treated with sulfuric acid. The filters are prepared by soaking each filter with 0.5 mL of 0.26 N H_2SO_4. (0.26 N H_2SO_4 can be prepared by diluting 1.5 mL of 36N H_2SO_4 to 200 mL with deionized water.) The filters are dried in an oven at 100 degrees C for one hour and then assembled into two-piece 37 mm polystyrene cassettes with backup pads. The cassettes are sealed with shrink bands and the ends are plugged with plastic plugs.

After sampling, the filters are carefully removed from the cassettes and individually transferred to small vials containing approximately 2 mL deionized water. The vials must be tightly sealed. The water can be added before or after the filters are transferred. The vials must be sealable and capable of holding at least 7 mL of liquid. Small glass scintillation vials with caps containing Teflon liners are recommended.

Reagents

Deionized water is needed for addition to the vials.

Sampling Technique

Immediately before sampling, remove the plastic plugs from the filter cassettes.

Attach the cassette to the sampling pump with flexible tubing and place the cassette in the employee's breathing zone.

After sampling, seal the cassettes with plastic plugs until the filters are transferred to the vials containing deionized water.

At some convenient time within 10 hours of sampling, transfer the sample filters to vials.

Seal the small vials lengthwise.

Submit at least one blank filter with each sample set. Blanks should be handled in the same manner as samples, but no air is drawn through them.

Record sample volumes (in L of air) for each sample, along with any potential interferences.

Retention Efficiency

A retention efficiency study was performed by drawing 100 L of air (80% relative humidity) at 1 L/min through sample filters that had been spiked with 0.814 μg MDA. Instead of using backup pads, blank acid-treated filters were used as backups in each cassette. Upon analysis, the top filters were found to have an average of 91.8% of the spiked amount. There was no MDA found on the bottom filters, so the amount lost was probably due to the slight instability of the MDA salt.

Extraction Efficiency

The average extraction efficiency for six filters spiked at the target concentration is 99.6%.

The stability of extracted and derivatized samples was verified by reanalyzing the above six samples the next day using fresh standards. The average extraction efficiency for the reanalyzed samples is 98.7%.

Recommended Air Volume and Sampling Rate

The recommended air volume is 100 L.

The recommended sampling rate is 1 L/min.

Interferences (Sampling)

MDI appears to be a positive interference. It was found that when MDI was spiked onto an acid-treated filter, the MDI converted to MDA after air was drawn through it.

Suspected interferences should be reported to the laboratory with submitted samples.

Safety Precautions (Sampling)

Attach the sampling equipment to the employees so that it will not interfere with work performance or safety.

Follow all safety procedures that apply to the work area being sampled.

Analytical Procedure

Apparatus: The following are required for analysis.

A GC equipped with an electron capture detector. For this evaluation a Tracor 222 Gas Chromatograph equipped with a Nickel 63 High Temperature Electron Capture Detector and a Linearizer was used.

A GC column capable of separating the MDA derivative from the solvent and interferences. A 6 ft × 2 mm ID glass column packed with 3% OV-101 coated on 100/120 Gas Chrom Q was used in this evaluation.

A electronic integrator or some other suitable means of measuring peak areas or heights.

Small resealable vials with Teflon-lined caps capable of holding 4 mL.

A dispenser or pipet for toluene capable of delivering 2.0 mL.

Pipets (or repipets with plastic or Teflon tips) capable of delivering 1 mL for the sodium hydroxide and buffer solutions.

A repipet capable of delivering 25 μL HFAA.

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Syringes for preparation of standards and injection of standards and samples into a GC.

Volumetric flasks and pipets to dilute the pure MDA in preparation of standards.

Disposable pipets to transfer the toluene layers after the samples are extracted.

Reagents

0.5 NaOH prepared from reagent grade NaOH.

Toluene, pesticide grade. Burdick and Jackson distilled in glass toluene was used.

Heptafluorobutyric acid anhydride (HFAA). HFAA from Pierce Chemical Company was used.

pH 7.0 phosphate buffer, prepared from 136 g potassium dihydrogen phosphate and 1 L deionized water. The pH is adjusted to 7.0 with saturated sodium hydroxide solution.

4,4'-Methylenedianiline (MDA), reagent grade.

Standard Preparation

Concentrated stock standards are prepared by diluting pure MDA with toluene. Analytical standards are prepared by injecting μL amount of diluted stock standards into vials that contain 2.0 mL toluene.

25 μL HFAA are added to each vial and the vials are capped and shaken for 10 seconds.

After 10 minutes. 1 mL of buffer is added to each vial.

The vials are recapped and shaken for 10 seconds.

After allowing the layers to separate, aliquots of the toluene (upper) layers are removed with a syringe and analyzed by GC.

Analytical standard concentrations should bracket sample concentrations. Thus, if samples fall out of the range of prepared standards, additional standards must be prepared to ascertain detector response.

Sample Preparation

The sample filters are received in vials containing deionized water.

1 mL of 0.5N NaOH and 2.0 mL toluene are added to each vial.

The vials are recapped and shaken for 10 minutes.

After allowing the layers to separate, approximately 1 mL aliquots of the toluene (upper) layers are transferred to separate vials with clean disposable pipets.

The toluene layers are treated and analyzed.

Analysis

GC conditions

Zone temperatures:
Column—220 degrees C
Injector—235 degrees C
Detector—335 degrees C

Gas flows, Ar/Ch4 Column—28 mL/min (95/5) Purge—40 mL/min

Injection volume: 5.0 μL

Column: 6 ft × 1/8 in ID glass, 3% OV-101 on 100/120 Gas Chrom Q

Retention time of MDA derivative: 3.5 minutes Chromatogram

Peak areas or heights are measured by an integrator or other suitable means.

A calibration curve is constructed by plotting response (peak areas or heights) of standard injections versus μg of MDA per sample. Sample concentrations must be bracketed by standards.

Interferences (Analytical)

Any compound that gives an electron capture detector response and has the same general retention time as the HFAA derivative of MDA is a potential interference. Suspected interference reported to the laboratory with submitted samples by the industrial hygienist must be considered before samples are derivatized.

GC parameters may be changed to possibly circumvent interferences.

Retention time on a single column is not considered proof of chemical identity. Analyte identity should be confirmed by GC/MS if possible.

Calculations

The analyte concentration for samples is obtained from the calibration curve in terms of μg MDA per sample. The extraction efficiency is 100%. If any MDA is found on the blank, that amount is subtracted from the sample amounts. The air concentrations are calculated using the following formulae.

μg/m3=(μg MDA per sample) (1000)/(L of air sampled)

ppb=(μg/m^3) (24.46)/(198.3)=(μg/m^3) (0.1233) where 24.46 is the molar volume at 25 degrees C and 760 mm Hg

Safety Precautions (Analytical)

Avoid skin contact and inhalation of all chemicals.

Restrict the use of all chemicals to a fume hood if possible.

Wear safety glasses and a lab coat at all times while in the lab area.

Appendix E to Section 1910.1050—Qualitative and Quantitative Fit Testing Procedures

Qualitative Fit Test Protocols

1. Isoamyl Acetate (banana oil) Protocol

A. Odor threshold screening.

1. Three 1-liter glass jars with metal lids (e.g. Mason or Bell jars) are required.

2. Odor-free water (e.g. distilled or spring water) at approximately 25 C shall be used for the solutions.

3. The isoamyl acetate (IAA) (also known as isopentyl acetate) stock solution is prepared by adding 1 cc of pure IAA to 800 cc of odor free water in a 1-liter jar and shaking for 30 seconds. This solution shall be prepared new at least weekly.

4. The screening test shall be conducted in a room separate from the room used for actual fit testing. The two rooms shall be well ventilated so that circulation of the test solution does not occur and cross contaminate the testing different sites [sic].

5. The odor test solution is prepared in a second jar by placing 0.4 cc of the stock solution into 500 cc of odor free water using a clean dropper or pipette. Shake for 30 seconds and allow to stand for two to three minutes so that the IAA concentration above the liquid may reach equilibrium. This solution may be used for only one day.

6. A test blank is prepared in a third jar by adding 500 cc of odor free water.

7. The odor test and test blank jars shall be labelled 1 and 2 for jar identification.

8. The following instructions shall be typed on a card and placed on the table in front of the two test jars (i.e., 1 and 2): "The purpose of this test is to determine if you can smell banana oil at a low concentration. The two bottles in front of you contain water. One of these bottles also contains a small amount of banana oil. Be sure the covers are on tight, then shake each bottle for two seconds. Unscrew the lid of each bottle, one at a time, and sniff at the mouth of the bottle. Indicate to the test conductor which bottle contains banana oil."

9. The mixtures used in the IAA odor detection test shall be prepared in an area separate from where the test is performed, in order to prevent olfactory fatigue in the subject.

10. If the test subject is unable to correctly identify the jar containing the odor test solution, the IAA qualitative fit test may not be used.

11. If the test subject correctly identifies the jar containing the odor test solution, the test subject may proceed to respirator selection and fit testing.

B. Respirator Selection.

1. The test subject shall be allowed to pick the most comfortable respirator from a selection including respirators of various sizes from different manufacturers. The selection shall include at least three sizes of elastomeric half facepieces, from at least two manufacturers.

2. The selection process shall be conducted in a room separate from the fit-test chamber to prevent odor fatigue. Prior to the selection process, the test subject shall be shown how to put on a respirator, how it should be positioned on the face, how to set strap tension and how to determine a "comfortable" respirator. A mirror shall be available to assist the subject in evaluating the fit and positioning of the respirator. This instruction may not constitute the subject's formal training on respirator use, as it is only a review.

3. The test subject should understand that the employee is being asked to select the respirator which provides the most comfortable fit.

4. The test subject holds each facepiece up to the face and eliminates those which obviously do not give a comfortable fit. Normally, selection will begin with a half-mask and if a comfortable fit cannot be found, the subject will be asked to test the full facepiece respirators. (A small percentage of users will not be able to wear any half mask.)

5. The more comfortable facepieces are noted; the most comfortable mask is donned and worn at least five minutes to assess comfort. All donning and adjustments of the facepiece shall be performed by the test subject without assistance from the test conductor or other person. Assistance in assessing comfort can be given by discussing the points in #6 below. If the test subject is not familiar with using a particular respirator, the test subject shall be directed to don the mask several times and to adjust the straps each time to become adept at setting proper tension on the straps.

6. Assessment of comfort shall include reviewing the following points with the test subject and allowing the test subject adequate time to determine the comfort of the respirator after donning:

- Positioning of mask on nose.
- Room for eye protection.
- Room to talk.
- Positioning mask on face and cheeks.

7. The following criteria shall be used to help determine the adequacy of the respirator fit:

- Chin properly placed.
- Strap tension.
- Fit across nose bridge.
- Distance from nose to chin.
- Tendency to slip.
- Self-observation in mirror.

8. The test subject shall perform the conventional negative or positive-pressure fit checks (e.g., see ANSI Z88.2-1980A7). Before beginning the negative- or positive-pressure test, the subject shall be told to "seat" the mask by rapidly moving the head from side-to-side and up and down, while taking a few deep breaths.

9. The test subject is now ready for fit testing.

10. After passing the fit test, the test subject shall be questioned again regarding the comfort of the respirator. If the respirator has become uncomfortable, another model of respirator shall be tried.

11. The employee shall be given the opportunity to select a different facepiece and to be retested if the chosen facepiece becomes increasingly uncomfortable at any time.

C. Fit Test.

1. The fit test chamber shall be similar to a clear 55 gallon drum liner suspended inverted over a 2-foot diameter frame, so that the top of chamber is about 6 inches above the test subject's head. The inside top center of the chamber shall have a small hook attached.

2. Each respirator used for the fitting and fit testing shall be equipped with organic vapor cartridges or offer protection against organic vapors. The cartridges or canisters shall be replaced as necessary to maintain the electiveness of the respirator.

3. After selecting, donning, and properly adjusting a respirator, the test subject shall wear it to the fit testing room. This room shall be separate from the room used for odor threshold screening and respirator selection, and shall be well ventilated, as by an exhaust fan or lab hood, to prevent general room contamination.

4. A copy of the following test exercises and Rainbow Passage shall be taped to the inside of the test chamber:

Test exercises

i. Breathe normally.

ii. Breathe deeply. Be certain breaths are *deep and regular.*

iii. Turn head all the way from one side to the other. Inhale on each side. Be certain movement is complete. Do not bump the respirator against the shoulders.

iv. Nod head up-and-down. Inhale when head is in the full up position (looking toward ceiling). Be certain motions are complete and made about every second. Do not bump the respirator on the chest.

v. Talking. Talk aloud and slowly for several minutes. The following paragraph is called the Rainbow Passage. Reading it aloud will result in a wide range of facial movements, and thus be useful to satisfy this requirement. Alternative passages which serve the same purpose may also be used.

vi. Jog in place.

vii. Breathe normally.

Rainbow Passage

When the sunlight strikes raindrops in the air, they act like a prism and form a rainbow. The rainbow is a division of white light into many beautiful colors. These take the shape of a long round arch, with its path high above, and its two ends apparently beyond the horizon. There is, according to legend, a boiling pot of gold at one end. People look, but no one ever finds it. When a man looks for something beyond reach, his friends say he is looking for the pot of gold at the end of the rainbow.

5. Each test subject shall wear the respirator for at a least 10 minutes before starting the fit test.

6. Upon entering the test chamber, the test subject shall be given a 6 inch by 5 inch piece of paper towel or other porous absorbent single ply material, folded in half and wetted with three-quarters of one cc of pure IAA. The test subject shall hang the wet towel on the hook at the top of the chamber.

7. Allow two minutes for the IAA test concentration to be reached before starting the fit-test exercises.

8. Each exercise described in #4 above shall be performed for at least one minute.

9. If at any time during the test, the subject detects the banana-like odor of IAA, the test has failed. The subject shall quickly exit from the test chamber and leave the test area to avoid olfactory fatigue.

10. If the test is failed, the subject shall return to the selection room and remove the respirator, repeat the odor sensitivity test, select and put on another respirator, return to the test chamber, and again begin the procedure described in the c(4) through c(8) above. The pro-

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cess continues until a respirator that fits well has been found. Should the odor sensitivity test be failed, the subject shall wait about 5 minutes before retesting. Odor sensitivity will usually have returned by this time.

11. If a person cannot pass the fit test described above wearing a half-mask respirator from the available selection, full facepiece models must be used.

12. When a respirator is found that passes the test, the subject must break the face seal and take a breath before exiting the chamber. This is to assure that the reason the test subject is not smelling the IAA is the good fit of the respirator facepiece seal and not olfactory fatigue.

13. When the test subject leaves the chamber, the subject shall remove the saturated towel and return it to the person conducting the test. To keep the area from becoming contaminated, the used towels shall be kept in a self-sealing bag so there is no significant IAA concentration buildup in the test chamber during subsequent tests.

14. Persons who have successfully passed this fit test with a half-mask respirator may be assigned the use of the test respirator in atmospheres with up to 10 times the PEL. In atmospheres greater than 10 times, and less than 50 times the PEL (up to 50 ppm), the subject must pass the IAA test using a full face negative pressure respirator. (The concentration of the IAA inside the test chamber must be increased by five times for QLFT of the full facepiece.)

15. The test shall not be conducted if there is any hair growth between the skin and the facepiece sealing surface

16. If hair growth or apparel interfere with a satisfactory fit, then they shall be altered or removed so as to eliminate interference and allow a satisfactory fit. If a satisfactory fit is still not attained, the test subject must use a positive-pressure respirator such as a powered air-purifying respirator, supplied air respirator, or self-contained breathing apparatus.

17. If a test subject exhibits difficulty in breathing during the tests, she or he shall be referred to a physician trained in respiratory diseases or pulmonary medicine to determine whether the test subject can wear a respirator while performing her or his duties.

18. Qualitative fit testing shall be repeated at least every 12 months.

19. In addition, because the sealing of the respirator may be affected, qualitative fit testing shall be repeated immediately when the test subject has a:

(1) Weight change of 20 pounds or more,

(2) Significant facial scarring in the area of the facepiece seal,

(3) Significant dental changes; i.e.; multiple extractions without prothesis, or acquiring dentures,

(4) Reconstructive or cosmetic surgery, or

(5) Any other condition that may interfere with facepiece sealing.

D. Record keeping.

A summary of all test results shall be maintained by the employer for 3 years. The summary shall include:

(1) Name of test subject.

(2) Date of testing.

(3) Name of the test conductor.

(4) Respirators selected (indicate manufacturer, model, size and approval number).

(5) Testing agent.

II. Saccharin Solution Aerosol Protocol

A. Respirator Selection.

Respirators shall be selected as described in section IB (respirator selection) above, except that each respirator shall be equipped with a particulate filter.

B. Taste Threshold Screening.

1. An enclosure placed over the head and shoulders shall be used for threshold screening (to determine if the individual can taste saccharin) and for fit testing. The enclosure shall be approximately 12 inches in diameter by 14 inches tall with at least the front clear to allow free movement of the head when a respirator is worn.

2. The test enclosure shall have a three-quarter inch hole in front of the test subject's nose and mouth area to accommodate the nebulizer nozzle.

3. The entire screening and testing procedure shall be explained to the test subject prior to conducting the screening test.

4. During the threshold screening test, the test subject shall don the test enclosure and breathe with open mouth with tongue extended.

5. Using a De Vilbiss Model 40 Inhalation Medication Nebulizer or equivalent, the test conductor shall spray the threshold check solution into the enclosure. This nebulizer shall be clearly marked to distinguish it from the fit test solution nebulizer.

6. The threshold check solution consists of 0.83 grams of sodium saccharin, USP in water. It can be prepared by putting 1 cc of the test solution (see C 7 below) in 100 cc of water.

7. To produce the aerosol, the nebulizer bulb is firmly squeezed so that it collapses completely, then is released and allowed to fully expand.

8. Ten squeezes of the nebulizer bulb are repeated rapidly and then the test subject is asked whether the saccharin can be tasted.

9. If the first response is negative, ten more squeezes of the nebulizer bulb are repeated rapidly and the test subject is again asked whether the saccharin can be tasted.

10. If the second response is negative ten more squeezes are repeated rapidly and the test subject is again asked whether the saccharin can be tasted.

11. The test conductor will take note of the number of squeezes required to elicit a taste response.

12. If the saccharin is not tasted after 30 squeezes (Step 10), the saccharin fit test cannot be performed on the test subject.

13. If a taste response is elicited, the test subject shall be asked to take note of the taste for reference in the fit test.

14. Correct use of the nebulizer means that approximately 1 cc of liquid is used at a time in the nebulizer body.

15. The nebulizer shall be thoroughly rinsed in water, shaken dry, and refilled at least every four hours.

C. Fit Test.

1. The test subject may not eat, drink (except plain water), or chew gum for 15 minutes before the test.

2. The test subject shall don and adjust the respirator without assistance from any person.

3. The fit test uses the same enclosure described in IIB above.

4. Each test subject shall wear the respirator for at least 10 minutes before starting the fit test.

(a) This would be an appropriate time to talk with the test subject; to explain the fit test, the importance of cooperation and, the purpose for the head exercises; or to demonstrate some of the exercises.

(b) The test subject shall perform the conventional negative or positive pressure fit tests (See ANSI Z88.2 1980 A7).

5. The test subject shall enter the enclosure while wearing the respirator selected in section IB above. This respirator shall be properly adjusted and equipped with a particulate filter.

6. A second DeVilbiss Model 40 Inhalation Medication Nebulizer is used to spray the fit test solution into the enclosure. This nebulizer shall be clearly marked to distinguish it from the screening test solution nebulizer.

7. The fit test solution is prepared by adding 83 grams of sodium saccharin to 100 cc of warm water.

8. As before, the test subject shall breathe with mouth open and tongue extended.

9. The nebulizer is inserted into the hole in the front of the enclosure and the fit test solution is sprayed into the enclosure using the same technique as for the taste threshold screening and the same number of squeezes required to elicit a taste response in the screening. (See B8 through B10 above.)

10. After generation of the aerosol read the following instructions to the test subject. The test subject shall perform the exercises for one minute each.

i. Breathe normally.

ii. Breathe deeply. Be certain breaths are *deep and regular.*

iii. Turn head all the way from one side to the other. Be certain movement is complete. Inhale on each side. Do not bump the respirator against the shoulders.

iv. Nod head up-and-down. Be certain motions are complete. Inhale when head is in the full up position (when looking toward the ceiling). Do not bump the respirator on the chest.

v. Talk. Talk aloud and slowly. The following paragraph is called the Rainbow Passage. Reading it will result in a wide range of facial movements, and thus be useful to satisfy this requirement.

vi. Jog in place.

vii. Breathe normally.

Rainbow Passage

When the sunlight strikes raindrops in the air, they act like a prism and form a rainbow. The rainbow is a division of white light into many beautiful colors. These take the shape of a long round arch, with its path high above, and its two ends apparently beyond the horizon. There is, according to legend, a boiling pot of gold at one end. People look, but no one ever finds it. When a man looks for something beyond his reach, his friends say he is looking for the pot of gold at the end of the rainbow.

11. At the beginning of each exercise, the aerosol concentration shall be replenished using one-half the number of squeezes as initially described in C9.

12. The test subject shall indicate to the test conductor if at any time during the fit test the taste of saccharin is detected.

13. If the saccharin is detected the fit is deemed unsatisfactory and a different respirator shall be tried.

14. Successful completion of the test protocol shall allow the use of the half mask tested respirator in contaminated atmospheres up to 10 times the PEL of MDA. In other words this protocol may not be used to assign protection factors higher than ten.

15. The test shall not be conducted if there is any hair growth between the skin and the facepiece sealing surface.

16. If hair growth or apparel interfere with a satisfactory fit, then they shall be altered or removed so as to eliminate interference and allow a satisfactory fit. If a satisfactory fit is still not attained, the test subject must use a positive-pressure respirator such as powered air-purifying respirators, supplied air respirator, or self-contained breathing apparatus.

17. If a test subject exhibits difficulty in breathing during the tests, she or he shall be referred to a physician trained in respiratory diseases or pulmonary medicine to determine whether the test subject can wear a respirator while performing her or his duties.

18. Qualitative fit testing shall be repeated at least every 12 months.

19. In addition, because the sealing of the respirator may be affected, qualitative fit testing shall be repeated immediately when the test subject has a:

(1) Weight change of 20 pounds or more,

(2) Significant facial scarring in the area of the facepiece seal,

(3) Significant dental changes; i.e.; multiple extractions without prothesis, or acquiring dentures,

(4) Reconstructive or cosmetic surgery, or

(5) Any other condition that may interfere with facepiece sealing.

D. Recordkeeping.

A summary of all test results shall be maintained by the employer for 3 years. The summary shall include:

(1) Name of test subject.

(2) Date of testing.

(3) Name of test conductor.

(4) Respirators selected (indicate manufacturer, model, size and approval number).

(5) Testing agent.

III. Irritant Fume Protocol

A. Respirator selection.

Respirators shall be selected as described in section IB above, except that each respirator shall be equipped with a combination of high-efficiency and acid-gas cartridges.

B. Fit Test.

1. The test subject shall be allowed to smell a weak concentration of the irritant smoke to familiarize the subject with the characteristic odor.

2. The test subject shall properly don the respirator selected as above, and wear it for at least 10 minutes before starting the fit test.

3. The test conductor shall review this protocol with the test subject before testing.

4. The test subject shall perform the conventional positive pressure and negative pressure fit checks (see ANSI Z88.2 1980). Failure of either check shall be cause to select an alternate respirator.

5. Break both ends of a ventilation smoke tube containing stannic oxychloride, such as the MSA part #5645, or equivalent. Attach a short length of tubing to one end of the smoke tube. Attach the other end of the smoke tube to a low pressure air pump set to deliver 200 milliliters per minute.

6. Advise the test subject that the smoke can be irritating to the eyes and instruct the subject to keep the eyes closed while the test is performed.

7. The test conductor shall direct the stream of irritant smoke from the tube towards the face seal area of the test subject. The person conducting the test shall begin with the tube at least 12 inches from the facepiece and gradually move to within one inch, moving around the whole perimeter of the mask.

8. The test subject shall be instructed to do the following exercises while the respirator is being challenged by the smoke. Each exercise shall be performed for one minute.

i. Breathe normally.

ii. Breathe deeply. Be certain breaths are deep and regular.

iii. Turn head all the way from one side to the other. Be certain movement is complete. Inhale on each side. Do not bump the respirator against the shoulders.

iv. Nod head up-and-down. Be certain motions are complete and made every second. Inhale when head is in the full up position (looking toward ceiling). Do not bump the respirator against the chest.

v. Talking. Talk aloud and slowly for several minutes. The following paragraph is called the Rainbow Passage. Reading it will result in a wide range of facial movements, and thus be useful to satisfy this requirement. Alternative passages which serve the same purpose may also be used.

Rainbow Passage

When the sunlight strikes raindrops in the air, they act like a prism and form a rainbow. The rainbow is a division of white light into many beautiful colors. These take the shape of a long round arch, with its path high above, and its two ends apparently beyond the horizon.

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There is, according to legend, a boiling pot of gold at one end. People look, but no one ever finds it. When a man looks for something beyond his reach, his friends say he is looking for the pot of gold at the end of the rainbow.

vi. Jogging in Place.

vii. Breathe normally.

9. The test subject shall indicate to the test conductor if the irritant smoke is detected. If smoke is detected, the test conductor shall stop the test. In this case, the tested respirator is rejected and another respirator shall be selected.

10. Each test subject passing the smoke test (i.e. without detecting the smoke) shall be given a sensitivity check of smoke from the same tube to determine if the test subject reacts to the smoke. Failure to evoke a response shall void the fit test.

11. Steps B4, B9, B10 of this fit test protocol shall be performed in a location with exhaust ventilation sufficient to prevent general contamination of the testing area by the test agents.

12. Respirators successfully tested by the protocol may be used in contaminated atmospheres up to ten times the PEL of MDA.

13. The test shall not be conducted if there is any hair growth between the skin and the facepiece sealing surface.

14. If hair growth or apparel interfere with a satisfactory fit, then they shall be altered or removed so as to eliminate interference and allow a satisfactory fit. If a satisfactory fit is still not attained, the test subject must use a positive-pressure respirator such as powered air-purifying respirators, supplied air respirator, or self-contained breathing apparatus.

15. If a test subject exhibits difficulty in breathing during the tests, she or he shall be referred to a physician trained in respiratory diseases or pulmonary medicine to determine whether the test subject can wear a respirator while performing her or his duties.

16. Qualitative fit testing shall be repeated at least every 12 months.

17. In addition, because the sealing of the respirator may be affected, qualitative fit testing shall be repeated immediately when the test subject has a:

(1) Weight change of 20 pounds or more,

(2) Significant facial scarring in the area of the facepiece seal,

(3) Significant dental changes; i.e.; multiple extractions without prothesis, or acquiring dentures,

(4) Reconstructive or cosmetic surgery, or

(5) Any other condition that may interfere with facepiece sealing.

C. Recordkeeping.

A summary of all test results shall be maintained by the employer for 3 years. The summary shall include:

(1) Name of test subject

(2) Date of testing.

(3) Name of test conductor.

(4) Respirators selected (indicate manufacturer, model, size and approval number).

(5) Testing agent.

Quantitative Fit Test Procedures

1. General.

a. The method applies to the negative pressure nonpowered air-purifying respirators only.

b. The employer shall assign an individual (with help as needed) who shall assume the full responsibility for implementing the respirator quantitative fit test program.

2. Definition.

a. "Quantitative Fit Test" means the measurement of the effectiveness of a respirator seal in excluding the ambient atmosphere. The test is performed by dividing the measured concentration of challenge agent in a test chamber by the measured concentration of the challenge agent inside the respirator facepiece when the normal air purifying element has been replaced by an essentially perfect purifying element.

b. "Challenge Agent" means the air contaminant introduced into a test chamber so that its concentration inside and outside the respirator may be compared.

c. "Test Subject" means the person wearing the respirator for quantitative fit testing.

d. "Normal Standing Position" means standing erect and straight with arms down along the sides and looking straight ahead.

e. "Fit Factor" means the ratio of challenge agent concentration outside with respect to the inside of a respirator inlet covering (facepiece or enclosure).

3. *Apparatus.*

a. *Instrumentation.* Corn oil, sodium chloride, or other appropriate aerosol generation, dilution, and measurement systems shall be used for quantitative fit test.

b. *Test chamber.* The test chamber shall be large enough to permit all test subjects to freely perform all required exercises without distributing the challenge agent concentration or the measurement apparatus. The test chamber shall be equipped and constructed so that the challenge agent is electively isolated from the ambient air yet uniform in concentration throughout the chamber.

c. When testing air-purifying respirators, the normal filter or cartridge element shall be replaced with a high-efficiency particulate filter supplied by the same manufacturer.

d. The sampling instrument shall be selected so that a strip chart record may be made of the test showing the rise and fall of challenge agent concentration with each inspiration and expiration at fit factors of at least 2,000.

e. The combination of substitute air-purifying elements (if any), challenge agent, and challenge agent concentration in the test chamber shall be such that the test subject is not exposed in excess of PEL to the challenge agent at any time during the testing process.

f. The sampling port on the test specimen respirator shall be placed and constructed so that there is no detectable leak around the port, a free air flow is allowed into the sampling line at all times and so there is no interference with the fit or performance of the respirator.

g. The test chamber and test set-up shall permit the person administering the test to observe one test subject inside the chamber during the test.

h. The equipment generating the challenge atmosphere shall maintain the concentration of challenge agent constant within a 10 percent variation for the duration of the test.

i. The time lag (interval between an event and its being recorded on the strip chart) of the instrumentation may not exceed 2 seconds.

j. The tubing for the test chamber atmosphere and for the respirator sampling port shall be the same diameter, length and material. It shall be kept as short as possible. The smallest diameter tubing recommended by the manufacturer shall be used.

k. The exhaust flow from the test chamber shall pass through a high-efficiency filter before release to the room.

l. When sodium chloride aerosol is used, the relative humidity inside the test chamber shall not exceed 50 percent.

4. *Procedural Requirements.*

a. The fitting of half-mask respirators should be started with those having multiple sizes and a variety of interchangeable cartridges and canisters such as the MSA Comfr II-M, Norton M, Survivair M A-O M or Scott-M. Use either of the tests outlined below to assure that the facepiece is properly adjusted.

(1) *Positive pressure test.* With the exhaust port(s) blocked the negative pressure of slight inhalation should remain constant for several seconds.

(2) *Negative pressure test.* With the intake port(s) blocked the negative pressure slight inhalation should remain constant for several seconds.

b. After a facepiece is adjusted, the test subject shall wear the facepiece for at least 5 minutes before conducting a qualitative test by using either of the methods described below and using the exercise regime described in 5.a., b., c., d., and e.

(1) *Isoamyl acetate test.* When using organic vapor cartridges, the test subject who can smell the odor should be unable to detect the odor of isoamyl acetate squirted into the air near the most vulnerable portions of the facepiece seal. In a location which is separated from the test area, the test subject shall be instructed to close her/his eyes during the test period. A combination cartridge or canister with organic vapor and high-efficiency filters shall be used when available for the particular mask being tested. The test subject shall be given an opportunity to smell the odor of isoamyl acetate before the test is conducted.

(2) *Irritant fume test.* When using high efficiency filters, the test subject should be unable to detect the odor of irritant fume (stannic chloride or titanium tetrachloride ventilation smoke tubes) squirted into the air near the most vulnerable portions of the facepiece seal. The test subject shall be instructed to close her/his eyes during the test period.

c. The test subject may enter the quantitative testing chamber only if she or he has obtained a satisfactory fit by as stated in 4.b. of this Appendix.

d. Before the subject enters the test chamber, a reasonably stable challenge agent concentration shall be measured in the test chamber.

e. Immediately after the subject enters the test chamber, the challenge agent concentration inside the respirator shall be measured to ensure that the peak penetration does not exceed 5 percent for a half-mask and 1 percent for a full facepiece.

f. A stable challenge agent concentration shall be obtained prior to the actual start of testing.

g. Respirator restraining straps may not be overtightened for testing. The straps shall be adjusted by the wearer to give a reasonably comfortable fit typical of normal use.

5. *Exercise Regime.* Prior to entering the test chamber, the test subject shall be given complete instructions as to her/his part in the test procedures. The test subject shall perform the following exercises, in the order given, for each independent test.

a. *Normal Breathing (NB).* In the normal standing position, without talking, the subject shall breathe normally for at least one minute.

b. *Deep Breathing (DB).* In the normal standing position the subject shall do deep breathing for at least one minute pausing so as not to hyperventilate.

c. *Turning head side to side (SS).* Standing in place the subject shall slowly turn his head from side [to side] between the extreme positions to each side. The head shall be held at each extreme position for at least 5 seconds. Perform for at least five complete cycles.

d. *Moving head up and down (UD).* Standing in place, the subject shall slowly move his head up and down between the extreme position straight up and the extreme position straight down. The head shall be held at each extreme position for at least 5 seconds. Perform for at least five complete cycles.

e. *Reading (R).* The subject shall read out slowly and loud so as to be heard clearly by the test conductor or monitor. The test subject shall read the "rainbow passage" at the end of this section.

f. *Grimace (G).* The test subject shall grimace, smile, frown, and generally contort the face using the facial muscles. Continue for at least 15 seconds.

g. *Bend over and touch toes (B).* The test subject shall bend at the waist and touch toes and return to upright position. Repeat for at least one minute.

h. *Jogging in place (J).* The test subject shall perform jog in place for at least one minute.

i. *Normal Breathing (NB).* In the normal standing position, without talking, the subject shall breathe normally for at least one minute.

Rainbow Passage

When the sunlight strikes raindrops in the air, they act like a prism and form a rainbow. The rainbow is a division of white light into many beautiful colors. These take the shape of a long round arch, with its path high above, and its two ends apparently beyond the horizon. There is, according to legend, a boiling pot of gold at one end. People look, but not one ever finds it. When a man looks for something beyond reach, his friends say he is looking for the pot of gold at the end of the rainbow.

6. *Termination of Tests.* The test shall be terminated whenever any single peak penetration exceeds 5 percent for half-masks and 1 percent for full facepieces. The test subject may be refitted and retested. If two of the three required tests are terminated, the fit shall be deemed inadequate. (See paragraph 4.h.).

7. *Calculation of Fit Factors:*

a. The fit factor determined by the quantitative fit test equals the average concentration inside the respirator.

b. The average test chamber concentration is the arithmetic average of the test chamber concentration at the beginning and of the end of the test.

c. The average peak concentration of the challenge agent inside the respirator shall be the arithmetic average peak concentrations for each of the nine exercises of the test which are computed as the arithmetic average of the peak concentrations found for each breath during the exercise.

d. The average peak concentration for an exercise may be determined graphically if there is not a great variation in the peak concentrations during a single exercise.

8. *Interpretation of Test Results.* The fit factor measured by the quantitative fit testing shall be the lowest of the three protection factors resulting from three independent tests.

9. *Other Requirements.*

a. The test subject shall not be permitted to wear a half-mask or full facepiece if the minimum fit factor of 250 or 1,250, respectively, cannot be obtained. If hair growth or apparel interfere with a satisfactory fit, then they shall be altered or removed so as to eliminate interference and allow a satisfactory fit. If a satisfactory fit is still not attained, the test subject must use a positive pressure respirator such as powered air-purifying respirators, supplied air respirator, or self-contained breathing apparatus.

b. The test shall not be conducted if there is any hair growth between the skin and the facepiece sealing surface.

c. If a test subject exhibits difficulty in breathing during the tests, she or he shall be referred to a physician to determine whether the test subject can wear a respirator while performing her or his duties.

d. The test subject shall be given the opportunity to wear the assigned respirator for one week. If the respirator does not provide a satisfactory fit during actual use, the test subject may request another QNFT which shall be performed immediately.

e. A respirator fit factor card shall be issued to the subject with the following information:

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(1) Name.

(2) Date of fit test.

(3) Protection factors obtained through each manufacturer, model and approval number of respirator tested.

(4) Name and signature of the person that conducted the test.

f. Filters used for qualitative or quantitative fit testing shall be replaced weekly, whenever increased breathing resistance is encountered, or when the test agent has altered the integrity of the filter media.

Organic vapor cartridges/canisters shall be replaced daily or sooner if there is any indication of breakthrough by the test agent.

10. *Retesting.* In addition, because the sealing of the respirator may be affected, quantitative fit testing shall be repeated immediately when the test subject has a:

(1) Weight change of 20 pounds or more,

(2) Significant facial scarring in the area of the facepiece seal,

(3) Significant dental changes; i.e.; multiple extractions without prosthesis, or acquiring dentures.

(4) Reconstructive or cosmetic surgery, or

(5) Any other condition that may interfere with facepiece sealing.

11. *Recordkeeping.*

a. A summary of all test results shall be maintained for three years. The summary shall include:

(1) Name of test subject

(2) Date of testing.

(3) Name of the test conductor.

(4) Fit factors obtained from every respirator tested (indicate manufacturer, model, size and approval number).

b. A copy of all test data including the strip chart and results shall be kept for at least five years.

§ 1910.1101 Asbestos [Removed]

[1910.1101 removed by 57 FR 24330, June 8, 1992]

§ 1910.1200 Hazard Communication

[Editor's note: The text of this standard is published in the "Hazard Communication" subtab at 31:9101]

APPENDIX A TO § 1910.1200—HEALTH HAZARD DEFINITIONS (MANDATORY)

Although safety hazards related to the physical characteristics of a chemical can be objectively defined in terms of testing requirements (e.g. flammability), health hazard definitions are less precise and more subjective. Health hazards may cause measurable changes in the body—such as decreased pulmonary function. These changes are generally indicated by the occurrence of signs and symptoms in the exposed employees—such as shortness of breath, a non-measurable, subjective feeling. Employees exposed to such hazards must be apprised of both the change in body function and the signs and symptoms that may occur to signal that change.

The determination of occupational health hazards is complicated by the fact that many of the effects or signs and symptoms occur commonly in nonoccupationally exposed populations, so that effects of exposure are difficult to separate from normally occurring illnesses. Occasionally, a substance causes an effect that is rarely seen in the population at large, such as angiosarcomas caused by vinyl chloride exposure, thus making it easier to ascertain that the occupational exposure was the primary causative factor. More often, however, the effects are common, such as lung cancer. The situation is further complicated by the fact that most chemicals have not been adequately tested to determine their health hazard potential, and data do not exist to substantiate these effects.

There have been many attempts to categorize effects and to define them in various ways. Generally, the terms "acute" and "chronic" are used to delineate between effects on the basis of severity or duration. "Acute" effects usually occur rapidly as a result of short-term exposures, and are of short duration. "Chronic" effects generally occur as a result of long-term exposure, and are of long duration.

The acute effects referred to most frequently are those defined by the American National Standards Institute (ANSI) standard for Precautionary Labeling of Hazardous Industrial Chemicals (Z129.1–1982)—irritation, corrosivity, sensitization and lethal dose. Although these are important health effects, they do not adequately cover the considerable range of acute effects which may occur as a result of occupational exposure, such as, for example, narcosis.

Similarly, the term chronic effect is often used to cover only carcinogenicity, teratogenicity, and mutagenicity. These effects are obvious a concern in the workplace, but again, do not adequately cover the area of chronic effects, excluding, for example, blood dyscrasias (such as anemia), chronic bronchitis and liver atrophy.

The goal of defining precisely, in measurable terms, every possible health effect that may occur in the workplace as a result of chemical exposures cannot realistically be accomplished. This does not negate the need for employees to be informed of such effects and protected from them.

Appendix B, which is also mandatory, outlines the principles and procedures of hazard assessment.

For purposes of this section, any chemicals which meet any of the following definitions, as determined by the criteria set forth in Appendix B are health hazards:

1. **Carcinogen:** A chemical is considered to be a carcinogen if:

(a) It has been evaluated by the International Agency for Research on Cancer (IARC), and found to be a carcinogen or potential carcinogen; or

(b) It is listed as a carcinogen or potential carcinogen in the *Annual Report on Carcinogens* published by the National Toxicology Program (NTP) (latest edition); or,

(c) It is regulated by OSHA as a carcinogen.

2. **Corrosive:** A chemical that causes visible destruction of, or irreversible alterations in, living tissue by chemical action at the site of contact. For example, a chemical is considered to be corrosive if, when tested on the intact skin of albino rabbits by the method described by the U.S. Department of Transportation in Appendix A to 49 CFR Part 173, it destroys or changes irreversibly the structure of the tissue at the site of contact following an exposure period of four hours. This term shall not refer to action on inanimate surfaces.

3. **Highly toxic:** A chemical falling within any of the following categories:

(a) A chemical that has a median lethal dose (LD_{50}) of 50 milligrams or less per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.

(b) A chemical that has a median lethal dose (LD_{50}) of 200 miligrams or less per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between two and three kilograms each.

(c) A chemical that has a median lethal concentration (LC_{50}) in air of 200 parts per million by volume or less of gas or vapor, or 2 milligrams per liter or less of mist, fume, or dust, when administered by continuous inhallation for one hour (or less if death occurs within one hour) to albino rats weighing between 200 and 300 grams each.

4. **Irritant:** A chemical, which is not corrosive, but which causes a reversible inflammatory effect on living tissue by chemical action at the site of contact. A chemical is a skin irritant if, when tested on the intact skin of albino rabbits by the mehtods of 16 CFR 1500.41 for four hours exposure or by other appropriate techniques, it results in an empirical score of five or more. A chemical is an eye irritant if so determined under the procedure listed in 16 CFR 1500.42 or other appropriate techniques.

5. **Sensitizer:** A chemical that causes a substantial proportion of exposed people or animals to develop an allergic reaction in normal tissue after repeated exposure to the chemicals.

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6. Toxic: A chemical falling within any of the following categories:

(a) A chemical that has a median lethal dose (LD_{50}) of more than 50 milligrams per kilogram but not more than 500 milligrams per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.

(b) A chemical that has a median lethal dose (LD_{50}) of more than 200 milligrams per kilogram but not more than 1,000 milligrams per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between two and three kilograms each.

(c) A chemical that has a median lethal concentration (LC_{50}) in air of more than 200 parts per million but not more than 2,000 parts per million by volume of gas or vapor, or more than two milligrams per liter but not more than 20 milligrams per liter of mist, fume, or dust, when administered by continuous inhalation for one hour (or less if death occurs within one hour) to albino rats weighing between 200 and 300 grams each.

7. Target organ effects. The following is a target organ categorization of effects which may occur, including examples of signs and symptoms and chemicals which have been found to cause such effects. These examples are presented to illustrate the range and diversity of effects and hazards found in the workplace, and the broad scope employers must consider in this area, but are not intended to be all-inclusive.

a. Hepatotoxins	Chemicals which produce liver damage.
Signs and Symptoms:	Jaundice; liver enlargement.
Chemicals	Carbon tetrachloride; nitrosamines.
b. Nephrotoxins:	Chemicals which produce kidney damage.
Signs and Symptoms:	Edema; proteinuria.
Chemicals:	Halogenated hydrocarbons; uranium.
c. Neurotoxins:	Chemicals which produce their primary toxic effects on the nervous system.
Signs and Symptoms:	Narcosis; behaviroal changes; decrease in motor functions.
Chemicals:	Mercury; carbon disulfide.
d. Agents which act on the blood of hematopoietic system:	Decreases hemoglobin function; deprive the body tissues of oxygen.
Signs and Symptoms:	Cyanosis; loss of consciousness.
Chemicals:	Carbon monoxide; cyanides.
e. Agents which damage the lung:	Chemicals which irritate or damage the pulmonary tissue.
Signs and Symptoms:	Cough; tightness in chest; shortness of breath.
Chemicals:	Silica; asbestos.
f. Reproductive toxins:	Chemicals which affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (feratogenesis).
Signs and Symptoms:	Birth defects; sterility.
Chemicals:	Lead; DBCP.
g. Cutaneous hazards:	Chemical which affect the dermal layer of the body.
Signs and Symptoms:	Defatting of the skin; rashes; irritation.
Chemicals:	Ketones; chlorinated compounds.
h. Eye hazards:	Chemicals which affect the eye or visual capacity.
Signs and Symptoms:	Conjunctivitis; corneal damage.
Chemicals:	Organic solvents; acids.

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APPENDIX B TO § 1910.1200—HAZARD DETERMINATION (MANDATORY)

The quality of a hazard communication program is largely dependent upon the adequacy and accuracy of the hazard determination. The hazard determination requirement of this standard is performance-oriented. Chemical manufacturers, importers, and employers evaluating chemicals are not required to follow any specific mehtods for determining hazards, but they must be able to demonstrate that they have adequately ascertained the hazards of the chemicals produced or imported in accordance with the criteria set forth in this Appendix.

Hazard evaluation is a process which relies heavily on the professional judgment of the evaluator, particularly in the area of chronic hazards. The performance-orientation of the hazard determination does diminish the duty of the chemical manufacturer, importer or employer to conduct a thorough evaluation, examining all relevant data and producing a scientifically defensible evaluation. For purposes of this standard, the following criteria shall be used in making hazard determinations that meet the requirements of this standard.

1. **Carcinogenicity:** As described in paragraph (d)(4) and Appendix A of this section, a determination by the National Toxicology Program, the International Agency for Research on Cancer, or OSHA that a chemical is a carcinogen or potential carcinogen will be considered conclusive evidence for purposes of this section.

2. **Human data:** Where available, epidemiological studies and case reports of adverse health effects shall be considered in the evaluation.

3. **Animal data:** Human evidence of health effects in exposed populations is generally not available for the majority of chemicals produced or used in the workplace. Therefore, the available results of toxicological testing in animal populations shall be used to predict the health effects that may be experienced by exposed workers. In particular, the definitions of certain acute hazards refer to specific animal testing results (see Appendix A).

4. **Adequacy and reporting of data.** The results of any studies which are designed and conducted according to established scientific principles, and which report statistically significant conclusions regarding the health effects of a chemical, shall be a sufficient basis for a hazard determination and reported on any material safety data sheet. The chemical manufacturer, importer, or employer may also report the results of other scientifically valid studies which tend to refute the findings of hazard.

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APPENDIX C TO § 1910.1200—INFORMATION SOURCES (ADVISORY)

The following is a list of available data sources which the chemical manufacturer, importer, or employer may wish to consult to evaluate the hazards of chemicals they produce or import:

— Any information in their own company files such as toxicity testing results or illness experience of company employees.

— Any information obtained from the supplier of the chemical, such as material safety data sheets or product safety bulletins.

— Any pertinent information obtained from the following source list (latest editions should be used):

Condensed Chemical Dictionary
Van Nostrand Reinhold Co., 135 West 50th Street, New York, NY 10020

The Merck Index: An Encyclopedia of Chemicals and Drugs
Merck and Company, Inc., 126 E. Lincoln Avenue, Rahway, NJ 07065

IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man
Geneva: World Health Organization, International Agency for Research on Cancer, 1972–1977. (Multivolume work), 49 Sheridan Street, Albany, New York

Industrial Hygiene and Toxicology, by F. A. Patty
John Wiley & Sons, Inc., New York, NY (Five volumes)

Clinical Toxicology of Commerical Products
Gleason, Gosselin and Hodge

Casarett and Doull's Toxicology; The Basic Science of Poisons
Doull, Klaassen, and Amdur, Macmillan Publishing Co., Inc., New York, NY

Industrial Toxicology, by Alice Hamilton and Harriet L. Hardy
Publishing Sciences Group, Inc., Acton, MA

Toxicology of the Eye, by W. Morton Grant
Charles C. Thomas, 301–327 East Lawrence Avenue, Springfield, IL

Recognition of Health Hazards in Industry
William A. Burgess, John Wiley and Sons, 605 Third Avenue, New York, NY 10158

Chemical Hazards of the Workplace
Nick H. Proctor and James P. Hughes, J. P. Lipincott Company, 6 Winchester Terrace, New York, NY 10022

Handbook of Chemistry and Physics
Chemical Rubber Company, 18901 Cranwood Parkway, Cleveland, OH 44128

Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with Intended Changes
American Conference of Governmental Industrial Hygienists, 6500 Glenway Avenue, Bldg. D–5, Cincinnati, OH 4521

Note.—The following documents are on sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Occupational Health Guidelines
NIOSH/OSHA (NIOSH Pub. No. 81–123)

NIOSH/OSHA Pocket Guide to Chemical Hazards
NIOSH Pub. No. 78–210

Registry of Toxic Effects of Chemical Substances
U.S. Department of Health and Human Services, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health (NIOSH Pub. No. 80–102)

The Industrial Environment—Its Evaluation and Control
U.S. Department of Health and Human Services, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health (NIOSH Pub. No. 74–117)

Miscellaneous Documents—National Institute for Occupational Safety and Health
1. Criteria for a recommended standard *** Occupational Exposure to "____"
2. Special Hazard Reviews
3. Occupational Hazard Assessment
4. Current Intellligence Bulletins

Bibiliographic Data Bases

Service Provider and File Name

Bibliographic Retrieval Services (BRS), Corporation Park, Bldg. 702, Scotia, New York 12302

AGRICOLA
BIOSIS PREVIEWS
CA CONDENSATES
CA SEARCH
DRUG INFORMATION
MEDLARS
MEDOC
NTIS
POLLUTION ABSTRACTS
SCIENCE CITATION INDEX
SSIE

Lockheed—DIALOG, Lockheed Missiles & Space Company, Inc., P.O. Box 44481, San Francisco, CA 94144
AGRICOLA
BIOSIS PREV. 1972–PRESENT
BIOSIS PREV. 1969–71
CA CONDENSATES 1970–71
CA SEARCH 1972–76
CA SEARCH 1977–PRESENT
CHEMNAME
CONFERENCE PAPERS INDEX
FOOD SCIENCE & TECH. ABSTR.
FOODS ADLIBRA
INTL. PHARMACEUTICAL ABSTR.
NTIS
POLLUTION ABSTRACTS
SCISEARCH 1978–PRESENT
SCISEARCH 1974–77
SSIE CURRENT RESEARCH

SDC—ORBIT, SDC Search Service, Department No. 2230, Pasadena, CA 91051
AGRICOLA
BIOCODES

R2

BIOSIS/BIO6973
CAS6771/CAS7276
CAS77
CHEMDEX
CONFERENCE
ENVIROLINE
LABORDOC
NTIS
POLLUTION
SSIE

Chemical Information System (CIS), Chemical Information Systems Inc., 7215 Yorke Road, Baltimore, MD 21212

Structure & Nomeclature Search System
Acute Toxicity (RTECS)
Clinical Toxicology of Commercial Products
Oil and Hazardous Materials Technical Assistance Data System

National Library of Medicine, Department of Health and Human Services, Public Health Service, National Institutes of Health, Bethesda, MD 20209

Toxicology Data Bank (TDB)
MEDLIN
TOXLINE
CANCERLIT
RTECS

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Appendix D to § 1910.1200 — Definition of "Trade Secret" (Mandatory)

[1910.120. Appendix D added at 50 FR 48758, November 27, 1985 on an interim basis and has been in effect since that time; this section was amended and adopted permanently at 51 FR 34597, September 30, 1986.]

The following is a reprint of the *Restatement of Torts* section 757, comment *b* (1939):

b. Definition of trade secret. A trade secret may consist of any formula, pattern, device or compilation of information which is used in one's business, and which gives him an opportunity to obtain an advantage over competitors who do not know or use it. It may be a formula for a chemical compound, a process of manufacturing, treating or preserving materials, a pattern for a machine or other device, or a list of customers. It differs from other secret information in a business (see § 759 of the *Restatement of Torts* which is not included in this Appendix) in that it is not simply information as to single or ephemeral events in the conduct of the business, as, for example, the amount or other terms of a secret bid for a contract or the salary of certain employees, or the security investments made or contemplated, or the date fixed for the announcement of a new policy or for bringing out a new model or the like. A trade secret is a process or device for continuous use in the operations of the business. Generally it relates to the production of goods, as, for example, a machine or formula for the production of an article. It may, however, relate to the sale of goods or to other operations in the business, such as a code for determining discounts, rebates or other concessions in a price list or catalogue, or a list of specialized customers, or a method of bookkeeping or other office management.

Secrecy. The subject matter of a trade secret must be secret. Matters of public knowledge or of a general knowledge in an industry cannot be appropriated by one as his secret. Matters which are completely disclosed by the goods which one markets cannot be his secret. Substantially, a trade secret is known only in the particular business in which it is used. It is not requisite that only the proprietor of the business know it. He may, without losing his protection, communicate it to employees involved in its use. He may likewise communicate it to others pledged to secrecy. Others may also know of it independently, as, for example, when they have discovered the process or formula by independent invention and are keeping it secret. Nevertheless, a substantial element of secrecy must exist, so that, except by the use of improper means, there would be difficulty in acquiring the information. An exact definition of a trade secret is not possible. Some factors to be considered in determining whether given information is one's trade secret are: (1) The extent to which the information is known outside his business; (2) the extent to which it is known by employees and others involved in his business; (3) the extent of measures taken by him to guard the secrecy of the information; (4) the value of the information to him and his competitors; (5) the amount of effort or money expended by him in developing the information; (6) the ease or difficulty with which the information could be properly acquired or duplicated by others.

Novelty and prior art. A trade secret may be a device or process which is patentable; but it need not be that. It may be a device or process which is clearly anticipated in the prior art or one which is merely a mechanical movement that a good mechanic can make. Novelty and invention are not requisite for a trade secret as they are for patentability. These requirements are essential to patentability because a patent protects against unlicensed use of the patented device or process even by one who discovers it properly through independent research. The patent monopoly is a reward to the inventor. But such is not the case with a trade secret. Its protection is not based on a policy of rewarding or otherwise encouraging the development of secret processes or devices. The protection is merely against breach of faith and reprehensible means of learning another's secret. For this limited protection it is not appropriate to require also the kind of novelty and invention which is a requisite of patentability. The nature of the secret is, however, an important factor in determining the kind of relief that is appropriate against one who is subject to liability under the rule stated in this Section. Thus, if the secret consists of a device or process which is a novel invention, one who acquires the secret wrongfully is ordinarily enjoined from further use of it and is required to account for the profits derived from his past use. If, on the other hand, the secret consists of mechanical improvements that a good mechanic can make without resort to the secret, the wrongdoer's liability may be limited to damages, and an injunction against future use of the improvements made with the aid of the secret may be inappropriate.

Appendix A to Section 1910.1030 — Hepatitis B Vaccine Declination (Mandatory)

[Added 1992]

I understand that due to my occupational exposure to blood or other potentially infectious materials I may be at risk of acquiring hepatitis B virus (HBV) infection. I have been given the opportunity to be vaccinated with hepatitis B vaccine, at no charge to myself. However, I decline hepatitis B vaccination at this time. I understand that by declining this vaccine, I continue to be at risk of acquiring hepatitis B, a serious disease. If in the future I continue to have occupational exposure to blood or other potentially infectious materials and I want to be vaccinated with hepatitis B vaccine, I can receive the vaccination series at no charge to me.

FRDoc. 91-28886 Filed 12-2-91; 8:45 am

BILLING CODE 4510-26-M

Appendix A to 1910.145O — National Research Council Recommendations Concerning Chemical Hygiene in Laboratories (Non-Mandatory)

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Foreword

As guidance for each employer's development of an appropriate laboratory Chemical Hygiene Plan, the following non-mandatory recommendations are provided. These recommendations are extracted from "Prudent Practices for Handling Hazardous Chemicals in Laboratories" (referred to below as "Prudent Practices"), which was published in 1981 by the National Research Council and is available from the National Academy Press, 2101 Constitution Ave., NW., Washington, DC 20418.

"Prudent Practices" is cited because of its wide distribution and acceptance and because of its preparation by members of the laboratory community through the sponsorship of the National Research Council. However, none of the recommendations given here will modify any requirements of the laboratory standard. This Appendix merely presents pertinent recommendations from "Prudent Practices," organized into a form convenient for quick reference during operation of a laboratory facility and during development and application of a Chemical Hygiene Plan. Users of this Appendix should consult "Prudent Practices" for a more extended presentation and justification for each recommendation.

"Prudent Practices" deals with both safety and chemical hazards, while the laboratory standard is concerned primarily with chemical hazards. Therefore, only those recommendations directed primarily toward control of toxic exposures are cited in this Appendix, with the term "chemical hygiene" being substituted for the word "safety." However, since conditions producing or threatening physical injury often pose toxic risks as well, page references concerning major categories of safety hazards in the laboratory are given.

The recommendations from "Prudent Practices" have been paraphrased, combined, or otherwise reorganized, and headings have been added. However, their sense has not been changed.

Corresponding Sections of the Standard and this Appendix

The following table is given for the convenience of those who are developing a Chemical Hygiene Plan which will satisfy the requirements of paragraph (e) of the standard. It indicates those sections of this Appendix which are most pertinent to each of the sections of paragraph (e) and related paragraphs:

Paragraph and topic in laboratory standard	Relevant appendix section
(e)(3)(i) Standard operating procedures for handling chemicals	C, D, E
(e)(3)(ii) Criteria to be used for implementation of measures to reduce exposures	D
(e)(3)(iii) Fume hood performance	C4b
(e)(3)(iv) Employee information and training (including emergency procedures)	D10, D9
(e)(3)(v) Requirements for prior approval of laboratory activities	E2b, E4b
(e)(3)(vi) Medical consultation and medical examinations	D5, E4f
(e)(3)(vii) Chemical hygiene responsibilities	B
(e)(3)(viii) Special precautions for work with particularly hazardous substances	E2, E3, E4

In this Appendix, those recommendations directed primarily at administrators and supervisors are given in sections A-D. Those recommendations of primary concern to employees who are actually handling laboratory chemicals are given in Section E. (Reference to page numbers in "Prudent Practices" are given in parentheses.)

A. General Principles for Work with Laboratory Chemicals

In addition to the more detailed recommendations listed below in sections B-E, "Prudent Practices" expresses certain general principles, including the following:

1. It is prudent to minimize all chemical exposures. Because few laboratory chemicals are without hazards, general precautions for handling all laboratory chemicals should be adopted, rather than specific guidelines for particular chemicals (2, 10). Skin contact with chemicals should be avoided as a cardinal rule (198).

2. Avoid underestimation of risk. Even for substances of no known significant hazard, exposure should be minimized. For work with substances which present special hazards, special precautions should be taken (10, 37, 38). One should assume that any mixture will be more toxic than its most toxic component (30, 103) and that all substances of unknown toxicity are toxic (3, 34).

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3. Provide adequate ventilation. The best way to prevent exposure to airborne substances is to prevent their escape into the working atmosphere by use of hoods and other ventilation devices (32, 198).

4. Institute a chemical hygiene program. A mandatory chemical hygiene program designed to minimize exposures is needed; it should be a regular, continuing effort, not merely a standby or short-term activity (6, 11). Its recommendations should be followed in academic teaching laboratories as well as by full-time laboratory workers (13).

5. Observe the PELS and TLVs. The Permissible Exposure Limits of OSHA and the Threshold Limit Values of the American Conference of Governmental Industrial Hygienists should not be exceeded (13).

B. Chemical Hygiene Responsibilities

Responsibility for chemical hygiene rests at all levels (6, 11, 21) including the:

1. Chief executive officer, who has ultimate responsibility for chemical hygiene within the institution and must, with other administrators, provide continuing support for institutional chemical hygiene (7, 11).

2. Supervisor of the department or other administrative unit, who is responsible for chemical hygiene in that unit (7).

3. Chemical hygiene officer(s), whose appointment is essential (7) and who must:

(a) Work with administrators and other employees to develop and implement appropriate chemical hygiene policies and practices (7);

(b) Monitor procurement, use, and disposal of chemicals used in the lab (8);

(c) See that appropriate audits are maintained (8);

(d) Help project directors develop precautions and adequate facilities (10);

(e) Know the current legal requirements concerning regulated substances (50); and

(f) Seek ways to improve the chemical hygiene program (8, 11).

4. Laboratory supervisor, who has overall responsibility for chemical hygiene in the laboratory (21) including responsibility to:

(a) Ensure that workers know and follow the chemical hygiene rules, that protective equipment is available and in working order, and that appropriate training has been provided (21, 22);

(b) Provide regular, formal chemical hygiene and housekeeping inspections including routine inspections of emergency equipment (21, 171);

(c) Know the current legal requirements concerning regulated substances (50, 231);

(d) Determine the required levels of protective apparel and equipment (156, 160, 162); and

(e) Ensure that facilities and training for use of any material being ordered are adequate (215).

5. Project director or director of other specific operation who has primary responsibility for chemical hygiene procedures for that operation (7).

6. Laboratory worker, who is responsible for:

(a) Planning and conducting each operation in accordance with the institutional chemical hygiene procedures (7, 21, 22, 230); and

(b) Developing good personal chemical hygiene habits (22).

C. The Laboratory Facility

1. Design. The laboratory facility should have:

(a) An appropriate general ventilation system with air intakes and exhausts located so as to avoid intake of contaminated air (194);

(b) Adequate, well-ventilated stockrooms/storerooms (218, 219);

(c) Laboratory hoods and sinks (12, 162);

(d) Other safety equipment including eyewash fountains and drench showers (162, 169); and

(e) Arrangements for waste disposal (12, 240).

2. Maintenance.

Chemical-hygiene-related equipment (hoods, incinerator, etc.) should undergo continuing appraisal and be modified if inadequate (11, 12).

3. Usage. The work conducted (10) and its scale (12) must be appropriate to the physical facilities available and, especially to the quality of ventilation (13).

4. Ventilation (a) General laboratory ventilation. This system should: provide a source of air for breathing and for input to local ventilation devices (199); it should not be relied on for protection from toxic substances released into the laboratory (198); ensure that laboratory air is continually replaced, preventing increase of air concentrations of toxic substances during the working day (194); direct air flow into the laboratory from non-laboratory areas and out to the exterior of the building (194).

(b) Hoods. A laboratory hood with 2.5 linear feet of hood space per person should be provided for every two workers if they spend most of their time working with chemicals (199); each hood should have a continuous monitoring device to allow convenient confirmation of adequate hood performance before use (200, 209). If this is not possible, work with substances of unknown toxicity should be avoided (13) or other types of local ventilation devices should be provided (199).

(c) Other local ventilation devices. Ventilated storage cabinets, canopy hoods, snorkels, etc., should be provided as needed (199). Each canopy hood and snorkel should have a separate exhaust duct (207).

(d) Special ventilation areas. Exhaust air from glove boxes and isolation rooms should be passed through scrubbers or other treatment before release into the regular exhaust system (208). Cold rooms and warm rooms should have provisions for rapid escape and for escape in the event of electrical failure (209).

(e) Modifications. Any alteration of the ventilation system should be made only if thorough testing indicates that worker protection from airborne toxic substances will continue to be adequate (12, 193, 204).

(f) Performance. Rate: 4-12 room air changes/hour is normally adequate general ventilation if local exhaust systems such as hoods are used as the primary method of control (194).

(g) Quality. General air flow should not be turbulent and should be relatively uniform throughout the laboratory, with no high velocity or static areas (194, 195); air flow into and within the hood should not be excessively turbulent (200); hood-face velocity should be adequate (200, 204).

(h) Evaluation. Quality and quantity of ventilation should be evaluated on installation (202), regularly monitored (at least every three months) (6, 12, 14, 195), and reevaluated whenever a change in local ventilation devices is made (12, 195, 207). See pp. 195-198 for methods of evaluation and for calculation of estimated airborne contaminant concentrations.

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D. Component of the Chemical Hygiene Plan

1. Basic Rules and Procedures (Recommendations for these are given in Section E.)

2. Chemical Procurement, Distribution, and Storage

(a) Procurement. Before a substance is received, information on proper handling, storage, and disposal should be known to those who will be involved (215, 216). No container should be accepted without an adequate identifying label (216). Preferably, all substances should be received in a central location (216).

(b) Stockrooms/storerooms. Toxic substances should be segregated in a well-identified area with local exhaust ventilation (221). Chemicals which are highly toxic (227) or other chemicals whose containers have been opened should be in unbreakable secondary containers (219). Stored chemicals should be examined periodically (at least annually) for replacement, deterioration, and container integrity (218-19).

Stockrooms/storerooms should not be used as preparation or repackaging areas, should be open during normal working hours, and should be controlled by one person (219).

(c) Distribution. When chemicals are hand-carried, the container should be placed in an outside container or bucket. Freight-only elevators should be used if possible (223).

(d) Laboratory storage. Amounts permitted should be as small as practical. Storage on bench tops and in hoods is inadvisable. Exposure to heat or direct sunlight should be avoided. Periodic inventories should be conducted, with unneeded items being discarded or returned to the storeroom/stockroom (225-6, 229).

3. Environmental Monitoring

Regular instrumental monitoring of airborne concentrations is not usually justified or practical in laboratories but may be appropriate when testing or redesigning hoods or other ventilation devices (12) or when a highly-toxic substance is stored or used regularly (e.g., three times/week) (13).

4. Housekeeping, Maintenance, and Inspections

(a) Cleaning. Floors should be cleaned regularly (24).

(b) Inspections. Formal housekeeping and chemical hygiene inspections should be held at least quarterly (6, 21) for units which have frequent personnel changes and semiannually for others; informal inspections should be continual (21).

(c) Maintenance. Eyewash fountains should be inspected at intervals of not less than three months (6). Respirators for routine use should be inspected periodically by the laboratory supervisor (169). Safety showers should be tested routinely (169). Other safety equipment should be inspected regularly (e.g., every 3 to 6 months) (6, 24, 171). Procedures to prevent restarting of out-of-service equipment should be established (25).

(d) Passageways. Stairways and hallways should not be used as storage areas (24). Access to exits, emergency equipment, and utility controls should never be blocked (24).

5. Medical Program

(a) Compliance with regulations. Regular medical surveillance should be established to the extent required by regulations (12).

(b) Routine surveillance. Anyone whose work involves regular and frequent handling of toxicologically significant quantities of chemicals should consult a qualified physician to determine on an individual basis whether a regular schedule of medical surveillance is desirable (11, 50).

(c) First aid personnel should be available during working hours and an emergency room with medical personnel should be nearby (173). See pp. 176-178 for description of some emergency first aid procedures.

6. Protective Apparel and Equipment

These should include for each laboratory:

(a) Protective apparel compatible with the required degree of protection for substances being handled (158-161);

(b) An easily accessible drench-type safety shower (162, 169);

(c) An eyewash fountain (162);

(d) A fire extinguisher (162-164);

(e) Respiratory protection (164-9), fire alarm and telephone for emergency use (162) should be available nearby; and

(f) Other items designated by the laboratory supervisor (156, 160).

7. Records

(a) Accident records should be written and retained (174).

(b) Chemical Hygiene Plan records should document that the facilities and precautions were compatible with current knowledge and regulations (7).

(c) Inventory and usage records for high-risk substances should be kept as specified in Section E3e.

(d) Medical records should be retained by the institution in accordance with the requirements of state and federal regulations (12).

8. Signs and Labels

Prominent signs and labels of the following types should be posted:

(a) Emergency telephone numbers of emergency personnel/facilities, supervisors, and laboratory workers (28);

(b) Identity labels, showing contents of containers (including waste receptacles) and associated hazards (27, 48);

(c) Location signs for safety showers, eyewash stations, other safety and first aid equipment, exits (27), and areas where food and beverage consumption and storage are permitted (24); and

(d) Warnings at areas or equipment where special or unusual hazards exist (27).

9. Spills and Accidents

(a) A written emergency plan should be established and communicated to all personnel; it should include procedures for ventilation failure (200), evacuation, medical care, reporting, and drills (172).

(b) There should be an alarm system to alert people in all parts of the facility including isolation areas such as cold rooms (172).

(c) A spill control policy should be developed and should include consideration of prevention, containment, cleanup, and reporting (175).

(d) All accidents or near accidents should be carefully analyzed with the results distributed to all who might benefit (8, 28).

10. Information and Training Program

(a) Aim: To assure that all individuals are adequately informed about the work in the laboratory, its risks, and what to do if an accident occurs (5, 15).

(b) Emergency and Personal Protection Training: Every laboratory worker should know the location and proper use of available protective apparel and equipment (154, 169). Some of the full-time personnel of the laboratory should be trained in the proper use of emergency equipment and procedures. Such training as well as first aid instruction should be available to (154) and encouraged for (176) everyone who might need it.

(c) Receiving and stockroom/storeroom personnel should know about hazards, handling equipment, protective apparel, and relevant regulations (217).

(d) Frequency of Training: The training and education program should be a regular, continuing activity — not simply an annual presentation (15).

(e) Literature/Consultation: Literature and consulting advice concerning chemical hygiene should be readily available to laboratory personnel, who should be encouraged to use these information resources (14).

11. Waste Disposal Program

(a) Aim: To assure that minimal harm to people, other organisms, and the environment will result from the disposal of waste laboratory chemicals (5).

(b) Content (14, 232, 233, 240): The waste disposal program should specify how waste is to be collected, segregated, stored, and transported and include consideration of what materials can be incinerated. Transport from the institution must be in accordance with DOT regulations (244).

(c) Discarding Chemical Stocks: Unlabeled containers of chemicals and solutions should undergo prompt disposal; if partially used, they should not be opened (24, 27). Before a worker's employment in the laboratory ends, chemicals for which that person was responsible should be discarded or returned to storage (226).

(d) Frequency of Disposal: Waste should be removed from laboratories to a central waste storage area at least once per week and from the central waste storage area at regular intervals (14).

(e) Method of Disposal: Incineration in an environmentally acceptable manner is the most practical disposal method for combustible laboratory waste (14, 238, 241). Indiscriminate disposal by pouring waste chemicals down the drain (14, 231, 242) or adding them to mixed refuse for landfill burial is unacceptable (14).

Hoods should not be used as a means of disposal for volatile chemicals (40, 200). Disposal by recycling (233, 243) or chemical decontamination (40, 230) should be used when possible.

E. Basic Rules and Procedures for Working with Chemicals

The Chemical Hygiene Plan should require that laboratory workers know and follow its rules and procedures. In addition to the procedures of the subprograms mentioned, these should include the following rules listed:

1. General Rules

The following should be used for essentially all laboratory work with chemicals:

(a) Accidents and spills — Eye contact: Promptly flush eyes with water for a prolonged period (15 minutes) and seek medical attention (33, 172). Ingestion: Encourage the victim to drink large amounts of water (178). Skin Contact: Promptly flush the affected area with water (33, 172, 178) and remove any contaminated clothing (172, 178). If symptoms persist after washing, seek medical attention (33).

Cleanup: Promptly clean up spills, using appropriate protective apparel and equipment and proper disposal (24 33). See pp. 233-237 for specific cleanup recommendations.

(b) Avoidance of ''routine'' exposure: Develop and encourage safe habits (23). Avoid unnecessary exposure to chemicals by any route (23). Do not smell or taste chemicals (32). Vent apparatus which may discharge toxic chemicals (vacuum pumps, distillation columns, etc.) into local exhaust devices (199). Inspect gloves (157) and test glove boxes (208) before use. Do not allow release of toxic substances in cold rooms and warm rooms, since these have contained recirculated atmospheres (209).

(c) Choice of chemicals: Use only those chemicals for which the quality of the available ventilation system is appropriate (13).

(d) Eating, smoking, etc.: Avoid eating, drinking, smoking, gum chewing, or application of cosmetics in areas where laboratory chemicals are present (22, 24, 32, 40); wash hands before conducting these activities (23, 24). Avoid storage, handling, or consumption of food or beverages in storage areas, refrigerators, glassware or utensils which are also used for laboratory operations (23, 24, 226).

(e) Equipment and glassware: Handle and store laboratory glassware with care to avoid damage; do not use damaged glassware (25). Use extra care with Dewar flasks and other evacuated glass apparatus; shield or wrap them to contain chemicals and fragments should implosion occur (25). Use equipment only for its designed purpose (23, 26).

(f) Exiting: Wash areas of exposed skin well before leaving the laboratory (23).

(g) Horseplay: Avoid practical jokes or other behavior which might confuse, startle, or distract another worker (23).

(h) Mouth suction: Do not use mouth suction for pipeting or starting a siphon (23, 32).

(i) Personal apparel: Confine long hair and loose clothing (23, 158). Wear shoes at all times in the laboratory but do not wear sandals, perforated shoes, or sneakers (158).

(j) Personal housekeeping: Keep the work area clean and uncluttered, with chemicals and equipment being properly labeled and stored; clean up the work area on completion of an operation or at the end of each day (24).

(k) Personal protection: Assure that appropriate eye protection (154-156) is worn by all persons, including visitors, where chemicals are stored or handled (22, 23, 33, 154). Wear appropriate gloves when the potential for contact with toxic materials exists (157); inspect the gloves before each use, wash them before removal, and replace them periodically (157).

Use appropriate (164-168) respiratory equipment when air contaminant concentrations are not sufficiently restricted by engineering controls (164-5), inspecting the respirator before use (169). Use any other protective and emergency apparel and equipment as appropriate (22, 157-162).

Avoid use of contact lenses in the laboratory unless necessary; if they are used, inform supervisor so special precautions can be taken (155). Remove laboratory coats immediately on significant contamination (161).

(l) Planning: Seek information and advice about hazards (7), plan appropriate protective procedures, and plan positioning of equipment before beginning any new operation (22, 23).

(m) Unattended operations: Leave lights on, place an appropriate sign on the door, and provide for containment of toxic substances in the event of failure of a utility service (such as cooling water) to an unattended operation (27, 128).

(n) Use of hood: Use the hood for operations which might result in release of toxic chemical vapors or dust (198-9).

As a rule of thumb, use a hood or other local ventilation device when working with any appreciably volatile substance with a TLV of less than 50 ppm (13). Confirm adequate hood performance before use: keep hood closed at all times except when adjustments within the hood are being made (200). Keep materials stored in hoods to a minimum and do not allow them to block vents or air flow (200). Leave the hood ''on'' when it is not in active use if toxic substances are stored in it or if it is uncertain whether adequate general laboratory ventilation will be maintained when it is ''off'' (200).

(o) Vigilance: Be alert to unsafe conditions and see that they are corrected when detected (22).

(p) Waste disposal: Assure that the plan for each laboratory operation includes plans and training for waste disposal (230). Deposit chemical waste in appropriately labeled receptacles and follow all other waste disposal procedures of the Chemical Hygiene Plan (22, 24). Do not discharge to the sewer concentrated acids or bases (231); highly toxic malodorous, or lachrymatory substances; or any substances which might interfere with the biological activity of waste water treatment plants, create fire or explosion hazards, cause structural damage or obstruct flow (242).

(q) Working alone: Avoid working alone in a building; do not work alone in a laboratory if the procedures being conducted are hazardous (28).

2. Allergens and Embryotoxins

(a) Allergens (examples: diazomethane, isocyanates, bichromates). Wear suitable gloves to prevent hand contact with allergens or substances of unknown allergenic activity (35).

(b) Embryotoxins (34-5) (examples: organomercurials, lead compounds, formamide). If you are a woman of childbearing age, handle these substances in a hood whose satisfactory performance has been confirmed using appropriate protective apparel (especially gloves) to prevent skin contact. Review each use of these materials with the research supervisor and review continuing uses annually or whenever a procedural change is made.

Store these substances, properly labeled, in an adequately ventilated area in an unbreakable secondary container. Notify supervisors of all incidents of exposure or spills; consult a qualified physician when appropriate.

3. Work with Chemicals of Moderate Chronic or High Acute Toxicity

Examples: diisopropylfluorophosphate (41), hydrofluoric acid (43), hydrogen cyanide (45).

(a) Aim: To minimize exposure to these toxic substances by any route using all reasonable precautions (39).

(b) Applicability: These precautions are appropriate for substances with moderate chronic or high acute toxicity used in significant quantities (39).

(c) Location: Use and store these substances only in areas of restricted access with special warning signs (40, 229). Always use a hood (previously evaluated to confirm adequate performance with a face velocity of at least 60 linear feet per minute) (40) or other containment device for procedures which may result in the generation of aerosols or vapors containing the substance (39); trap released vapors to prevent their discharge with the hood exhaust (40).

(d) Personal protection: Always avoid skin contact by use of gloves and long sleeves (and other protective apparel as appropriate).

(e) Records: Maintain records of the amounts of these materials on hand, amounts used, and the names of the workers involved (40, 229).

(f) Prevention of spills and accidents: Be prepared for accidents and spills (41). Assure that at least two people are present at all times if a compound in use is highly toxic or of unknown toxicity (39). Store breakable containers of these substances in chemically-resistant trays; also work and mount apparatus above such trays or cover work and storage surfaces with removable, absorbent, plastic backed paper (40). If a major spill occurs outside the hood, evacuate the area; assure that cleanup personnel wear suitable protective apparel and equipment (41).

(g) Waste: Thoroughly decontaminate or incinerate contaminated clothing or shoes (41). If possible, chemically decontaminate by chemical conversion (40). Store contaminated waste in closed, suitably labeled, impervious containers (for liquids, in glass or plastic bottles half-filled with vermiculite) (40).

4. Work with Chemicals of High Chronic Toxicity

[Examples: dimethylmercury and nickel carbonyl (48), benzo-a-pyrene (51), N-nitrosodiethylamine (54), other human carcinogens or substances with high carcinogenic potency in animals (38).]

Further supplemental rules to be followed, in addition to all these mentioned above, for work with substances of known high chronic toxicity (in quantities above a few milligrams to a few grams, depending on the substance) (47).

(a) Access: Conduct all transfers and work with these substances in a "controlled area": a restricted access hood, glove box, or portion of a lab, designated for use of highly-toxic substances, for which all people with access are aware of the substances being used and necessary precautions (48).

(b) Approvals: Prepare a plan for use and disposal of these materials and obtain the approval of the laboratory supervisor (48).

(c) Non-contamination/Decontamination: Protect vacuum pumps against contamination by scrubbers or HEPA filters and vent them into the hood (49). Decontaminate vacuum pumps or other contaminated equipment, including glassware, in the hood before removing them from the controlled area (49, 50). Decontaminate the controlled area before normal work is resumed there (50).

(d) Exiting: On leaving a controlled area, remove any protective apparel (placing it in an appropriate, labeled container) and thoroughly wash hands, forearms, face, and neck (49).

(e) Housekeeping: Use a wet mop or a vacuum cleaner equipped with a HEPA filter instead of dry sweeping if the toxic substance was a dry powder (50).

(f) Medical surveillance: If using toxicologically significant quantities of such a substance on a regular basis (e.g., three times per week), consult a qualified physician concerning desirability of regular medical surveillance (50).

(g) Records: Keep accurate records of the amounts of these substances stored (229) and used, the dates of use, and names of users (48).

(h) Signs and labels: Assure that the controlled area is conspicuously marked with warning and restricted access signs (49) and that all containers of these substances are appropriately labeled. (48).

(i) Spills: Assure that contingency plans, equipment, and materials to minimize exposures of people and property in case of accident are available (233-4).

(j) Storage: Store containers of these chemicals only in a ventilated, limited access (48, 227, 229) area in appropriately labeled, unbreakable, chemically resistant, secondary containers (48, 229).

(k) Glove boxes: For a negative pressure glove box, ventilation rate must be at least two volume changes/hour and pressure at least 0.5 inches of water (48). For a positive pressure glove box, thoroughly check for leaks before each use (49). In either case. trap the exit gases or filter them through a HEPA filter and then release them into the hood (49).

(l) Waste: Use chemical decontamination whenever possible; ensure that containers of contaminated waste (including washings from contaminated flasks) are transferred from the controlled area in a secondary container under the supervision of authorized personnel (49, 50, 233).

5. Animal Work with Chemicals of High Chronic Toxicity

(a) Access: For large-scale studies, special facilities with restricted access are preferable (56).

(b) Administration of the toxic substance: When possible, administer the substance by injection or gavage instead of in the diet. If administration is in the diet, use a caging system under negative pressure or under laminar air flow directed toward HEPA filters (56).

(c) Aerosol suppression: Devise procedures which minimize formation and dispersal of contaminated aerosols, including those from food, urine and feces (e.g., use HEPA filtered vacuum equipment for cleaning, moisten contaminated bedding before removal from the cage, mix diets in closed containers in a hood) (55, 56).

(d) Personal protection: When working in the animal room, wear plastic or rubber gloves, fully buttoned laboratory coat or jumpsuit and, if needed because of incomplete suppression of aerosols, other apparel and equipment (shoe and head coverings, respirator) (56).

(e) Waste disposal: Dispose of contaminated animal tissues and excreta by incineration if the available incinerator can convert the contaminant to nontoxic products (238); otherwise, package the waste appropriately for burial in an EPA-approved site (239).

F. Safety Recommendations

The recommendations from "Prudent Practices" do not include those which are directed primarily toward prevention of physical injury rather than toxic exposure. However, failure of precautions against injury will often have the secondary effect of causing toxic exposures. The following is a list of page references for recommendations concerning some of the major categories of safety hazards which also have implications for chemical hygiene:

1. Corrosive agents: (35-6)
2. Electrically-powered laboratory apparatus (179-92)
3. Fires and explosions: (26, 57-74, 162-4, 174-5, 219-20, 226-7)
4. Low-temperature procedures: (26, 88)
5. Pressurized vacuum operations: (27, 75-101)

G. Material Safety Data Sheets

Material Safety Data Sheets are presented in "Prudent Practices" for the chemicals listed below:

Acetyl peroxide (105)
Acrolein (106)
Ammonia (91)
Benzene (110)
Benzo(a)pyrene (112)
Bis (chloromethyl) ether (113)
Boron trifluoride (92)
Bromine (114)
Tert-butyl hydroperoxide (148)
Carbon disulfide (116)
Carbon monoxide (92)
Carbon tetrachloride (118)
Chlorine (119)
Chlorine trifluoride (94)
Chloroform (121)
Chloromethane (93)
Diethyl ether (122)
Diisopropyl fluorophosphate (41)
Dimethylformamide (123)
Dimethyl sulfate (125)
Dioxane (126)
Ethylene dibromide (128)
Fluorine (95)
Formaldehyde (130)
Hydrazine and salts (132)
Hydrofluoric acid (43)
Hydrogen bromide (98)
Hydrogen chloride (98)
Hydrogen cyanide (133)
Hydrogen sulfide (135)
Mercury and compounds (52)
Methanol (137)
Morpholine (138)
Nickel carbonyl (99)
Nitrobenzene (139)
Nitrogen dioxide (100)
N-nitrosodiethylamine (54)
Peracetic acid (141)
Phenol (142)
Phosgene (143)
Pyridine (144)
Sodium azide (145)
Sodium cyanide (147)
Sulfur dioxide (101)
Trichloroethylene (149)
Vinyl chloride (150)

Appendix B to 1910.1450 — References (Non-Mandatory)

The following references are provided to assist the employer in the development of a Chemical Hygiene Plan. The materials listed below are offered as non-mandatory guidance. References listed here do not imply a specific endorsement of a book, opinion, policy, or specific solution for a safety or health problem. Other references not listed here may better meet the needs of a specific laboratory.

(a) Materials for the Development of the Chemical Hygiene Plan:

1. American Chemical Society, *Safety in Academic Chemistry Laboratories*, 4th edition, 1985.

2. Fawcett, H.H. and Wood, W.S., *Safety and Accident Prevention in Chemical Operations*, 2nd edition. Wiley-Interscience, New York 1982.

3. Flury, Patricia A., *Environmental Health and Safety in the Hospital Laboratory*, Charles C. Thomas Publisher, Springfield, IL, 1978.

4. Green, Michael E. and Turk, Amos, *Safety in Working with Chemicals*, Macmillan Publishing Co., NY, 1978.

5. Kaufman, James A., *Laboratory Safety Guidelines*, Dow Chemical Co., Box 1713, Midland, MI 48640, 1977.

6. National Institutes of Health, *NIH Guidelines for the Laboratory Use of Chemical Carcinogens*, NIH Pub. No. 81-2385, GPO, Washington, DC 20402, 1981.

7. National Research Council, "Prudent Practices for Disposal of Chemicals from Laboratories," National Academy Press, Washington, DC, 1983.

8. National Research Council, "Prudent Practices for Handling Hazardous Chemicals in Laboratories," National Academy Press, Washington, DC, 1981.

9. Renfrew, Malcolm, Ed., *Safety in the Chemical Laboratory*, Vol. IV, American Chemical Society, Easlon, PA 18042, 1981.

10. Steere, Norman V., Ed., *Safety in the Chemical Laboratory*, American Chemical Society, Easlon, PA, 18042. Vol. 1. 1967, Vol. II, 1971, Vol. III 1974.

11. Steere, Norman V., *Handbook of Laboratory Safety*, the Chemical Rubber Company, Cleveland, OH, 1971.

12. Young, Jay A., Ed., *Improving Safety in the Chemical Laboratory*, John Wiley & Sons, Inc., New York, 1987.

(b) Hazardous Substances Information:

1. American Conference of Governmental Industrial Hygienists, *Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with Intended Changes*, P.O. Box 1937 Cincinnati, OH 45201 (latest edition).

2. *Annual Report on Carcinogens*, National Toxicology Program U.S. Department of Health and Human Services, Public Health Service, U.S. Government Printing Office, Washington, DC, (latest edition).

3. Bretherick, L., *Handbook of Reactive Chemical Hazards*, 2nd edition, Butterworths, London, 1979.

4. Bretherick, L., *Hazards in the Chemical Laboratory*, 3rd edition, Royal Society of Chemistry, London, 1986.

5. *Code of Federal Regulations*, 29 CFR part 1910 Subpart Z. U.S. GPO Washington, DC 20402 (latest edition).

6. *IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man*, World Health Organization Publications Center, 49 Sheridan Avenue, Albany, New York 12210 (latest editions).

7. *NIOSH/OSHA Pocket Guide to Chemical Hazards*, NIOSH Pub. No. 85-114, U.S. Government Printing Office, Washington, DC, 1985 (or latest edition).

8. *Occupational Health Guidelines*, NIOSH/OSHA NIOSH Pub. No. 81-123 U.S. Government Printing Office, Washington, DC, 1981.

9. Patty, F.A., *Industrial Hygiene and Toxicology*, John Wiley & Sons, Inc., New York, NY (Five Volumes).

10. *Registry of Toxic Effects of Chemical Substances*, U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, Revised Annually, for sale from Superintendent of Documents U.S. Govt. Printing Office, Washington, DC 20402.

11. *The Merck Index: An Encyclopedia of Chemicals and Drugs*, Merck and Company Inc., Rahway, NJ 1976 (or latest edition).

12. Sax, N.I., *Dangerous Properties of Industrial Materials*, 5th edition, Van Nostrand Reinhold NY, 1979.

13. Sittig, Marshall, *Handbook of Toxic and Hazardous Chemicals*, Noyes Publications. Park Ridge, NJ, 1981.

(c) Information on Ventilation:

1. American Conference of Governmental Industrial Hygienists Industrial Ventilation, 16th edition, Lansing, MI, 1980.

2. American National Standards Institute, Inc., *American National Standards Fundamentals Governing the Design and Operation of Local Exhaust Systems* ANSI Z 9.2-1979 American National Standards Institute, NY 1979.

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EMERGENCY PLANNING AND COMMUNITY RIGHT-TO-KNOW ACT OF 1986

The following information covers the U.S. Environmental Protection Agency's (EPA) Superfund Amendments and Reauthorization Act (SARA) Title III.

Although the OSHA Reference Manual is intended to cover the federal regulations and standards associated with the Occupational Safety and Health Act, these EPA requirements and the necessary forms are included because of their importance to many of our subscribers. The main objective of this Chapter is to guide readers through provision 372, which addresses Toxic Chemical Release Reporting.

OVERVIEW OF SARA: TITLE III

Title III of the Superfund Amendments and Reauthorization Act (SARA), and more specifically section 313 of the act, sets federal, state, and local government requirements and guidelines for business and industry for the gathering and submission of information relating to the release of toxic chemicals into the environment. The intent of this legislation is to inform the general public and communities which surround covered facilities about releases of toxic chemicals.

This act builds on other regulatory acts and attempts to set uniform requirements with that of the Hazard Communication Standard of the Occupational Safety and Health Act (OSHA).

Where the original CERCLA or Superfund legislation of 1980 attempted to deal with emergency responses and cleanup of hazardous waste problems of the past, SARA focuses on the present and anticipated problems of toxic materials in order to eliminate or minimize future cleanup costs.

Under Section 313 of the Emergency Planning and Community Right-to-Know Act (also known as Title III of SARA), certain businesses are now required to submit reports each year on the amount of chemicals their facilities release into the environment, either routinely, or as a result of accidents. The reports must be submitted to the Environmental Protection Agency and to designated state agencies. Those who fail to report are subject to penalties of up to $25,000 a day.

WHO MUST REPORT

A plant, factory, or other facility falls under the provisions of Section 313 if it conducts manufacturing operations included in Standard Industrial Classification (SIC) codes 20 through 39. SIC groups subject to 313 include:

SIC	Industry Group
20	Food
21	Tobacco
22	Textiles
23	Apparel

24	Lumber and Wood
25	Furniture
26	Paper
27	Printing and Publishing
28	Chemicals
29	Petroleum and Coal
30	Rubber and Plastics
31	Leather
32	Stone, Clay, and Glass
33	Primary Metals
34	Fabricated Metals
35	Machinery (Excluding Electrical)
36	Electrical and Electronic Equipment
37	Transportation Equipment
38	Instruments
39	Miscellaneous Manufacturing

In addition to the above, a facility must report if it manufactures, imports, processes, or in any other way uses any toxic chemicals listed by the EPA in amounts greater than the ''threshold'' specified in Part 372.25. Presently, there are 308 individual chemicals, and 20 categories of chemicals that are covered. To obtain a list of chemicals subject to reporting, write to: EPA Section 313, Document Distribution Center P.O. Box 12505, Cincinnati, OH 45212; or call the Community Right-to-Know Hotline, (800) 535 -0202.

The following presents only select portions of amendments to Chapter I of 40 CFR which added Part 372 to the previously enacted Superfund Amendment.

PART 372 — TOXIC CHEMICAL RELEASE REPORTING; COMMUNITY RIGHT-TO-KNOW

Sections of Part 372 presented are:

Subpart A — General Provisions

372.1	Scope and Purpose
372.3	Definitions
372.5	Persons subject to this Part
372.10	Recordkeeping
372.18	Compliance and Enforcement

Subpart B — Reporting Requirements

372.22 Covered facilities for release reporting

372.25 Thresholds for reporting

372.30 Reporting requirements and schedules

372.38 Exemptions

Subpart C — Supplier Notification Requirements

372.45 Notification about toxic chemicals

Subpart D — Specific Toxic Chemical Listings

372.65 Chemicals and chemical categories applicable

Subpart E — Forms and Instructions

372.85 Toxic chemical release reporting forms

SUBPART A — GENERAL PROVISIONS

372.1 Scope and Purpose

This Part deals with the requirements for submitting information relating to the release of toxic chemicals under section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986. The information collected is intended to:

- inform the general public and communities surrounding covered facilities about releases of toxic chemicals;
- aid in development of regulations, guidelines, standards, and other related needs and purposes; and
- assist research.

Subpart A also sets requirements for suppliers to notify persons to whom they distribute mixtures or trade name products containing toxic chemicals.

372.3 Definitions applicable to this Part

Terms defined in sections 313(b)(1)(c) and 329 of Title III and not explicitly defined herein are used with the meaning given in Title III.

The following is a list of terms associated with Title III:

Acts — Title III

Article — A manufactured item which:

1) is formed to a specific shape or design during manufacture;
2) has end use functions dependent on its shape or design during end use; and
3) does not release a toxic chemical under normal conditions of processing or use.

Customs Territory of the United States — The 50 states, the District of Columbia, and Puerto Rico.

EPA — The U.S. Environmental Protection Agency.

Establishment — An economic unit, generally at a single physical location, where business is conducted or where services or industrial operations are performed.

Facility — All buildings, equipment, structures, and other stationary items which are located on a single site or on contiguous or adjacent sites and which are owned or operated by the same person (or by any person which controls, is controlled by, or under common control with such person). A facility may contain more than one establishment.

Full-time Employee — 2,000 hours per year of full-time equivalent employment. A facility would calculate the number of full-time employees by totaling the hours worked during calendar year by all employees, including contract employees, and dividing that total by 2,000 hours.

HS — Hazardous Substance.

Import — To cause a chemical to be imported into the customs territory of the United States. (''To cause,'' for purpose of this definition means to intend that the chemical be imported and to control the identity of the imported chemical and amount to be imported.)

LEPC — Local Emergency Planning Committee. Appointed by the State Emergency Response Commission.

Manufacture — To produce, prepare, import, or compound a toxic chemical. Manufacture also applies to a toxic chemical that is produced coincidentally during the manufacturing, processing, use, or disposal of another chemical or mixture of chemicals, including a toxic chemical that is separated from that other chemical or mixture as a byproduct, and a toxic chemical that remains in that other chemical or mixture as an impurity.

Mixture — Any combination of two or more chemicals, if the combination is not, in whole or in part, the result of a chemical reaction. A chemical produced by chemical reaction, but which could have been produced without a chemical reaction, is also treated as a mixture. Also included as a mixture is any combination which consists of a chemical and associated impurities.

Otherwise Use — Use of a toxic chemical that is not covered by the term manufacture or process. Included in this meaning is use of a toxic chemical contained in a mixture or trade name product. Relabeling or redistributing a container of a toxic chemical where no repackaging of the toxic chemical occurs does not constitute use or processing.

Process — Preparation of a toxic chemical, after its manufacture for distribution in commerce:

1) in same or different form or physical shape as originally received by person preparing the substance; or
2) as part of an article containing the toxic chemical.

   Process also applies to processing of a toxic chemical contained in a mixture or trade name product.

Release — Applies to and can mean any of the following: spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment (including the abandonment or discarding of barrels, containers, and other closed receptacles) of any toxic chemical.

Senior Management Official — An official with management responsibility for the person or persons completing the reports; or the manager of environmental programs for the facility or establishments; or for the corporation owning or operating the facility; or establishments responsible for certifying similar reports under other environmental regulatory requirements.

SIC — Standard Industrial Classification. Created by the Bureau of Labor Statistics.

Title III — Title III of the Superfund Amendments and Reauthorization Act of 1986, also titled the Emergency Planning and Community Right-To-Know Act of 1986.

Toxic Chemical — A chemical or chemical category listed in section 372.65.

TPQ — Threshold Planning Quantity.

Trade Name Product — A chemical or mixture of chemicals that is distributed to other persons and that incorporates a toxic chemical component that is not identified by the applicable chemical name or Chemical Abstract Service Registry number (CAS No.) listed in 372.65.

372.5 Persons Subject to this Part

Owners and operators of facilities described in 372.22 and 372.45. If owners and operators are different persons, only one (owner or the operator) needs to report under 372.17 or provide a notice under 372.45 for each toxic chemical in a mixture or trade name product distributed from the facility.

If no report is submitted or notice provided, as required, both the owner and the operator will be held liable under section 325(c) [except as provided in 372.38(e) or 372.43(g)].

372.10 Recordkeeping

(a) Persons subject to reporting requirements must retain the following records for a period of three years from date of submission of a report under 372.30:

(1) Copy of each report submitted.

(2) All supporting materials and documentation used by the person to make the compliance determination that the facility or establishment is a covered facility under 372.22 or 372.45.

(3) Documentation supporting the report submitted, including:

(i) Supporting documentation for a claimed allowable exemption under 372.38.

(ii) Supporting data used to determine whether a threshold under 372.25 applies for each toxic chemical.

(iii) Documentation supporting calculations of quantity of each toxic chemical released to the environment or transferred to an off-site location.

(iv) Documentation supporting use indications and quantity on-site reporting for each toxic chemical, including dates of manufacturing, process, or use.

(v) Documentation supporting basis for estimating release or off-site transfer of each toxic chemical.

(vi) Receipts or manifests associated with transfer of each toxic chemical in waste to off-site locations.

(vii) Documentation supporting reported waste treatment methods; estimates of treatment efficiencies; ranges of influent concentration to such treatment; sequential nature of treatment steps, if applicable, and actual operating data, if applicable, to support waste treatment efficiency estimate for each toxic chemical.

(b) Each person subject to notification requirements of this Part must keep the following records for a period of three years from date of submission of a notification under 372.45:

(1) Supporting materials and documentation used to determine whether notice is required.

(2) Supporting materials and documentation used in developing required notice, and a copy of each notice

(c) Records must be maintained at the facility to which the report applies or from which a notification was provided.

Such records must be readily available for inspection by EPA.

372.18 Compliance and Enforcement

Violators of this Part shall be liable for civil penalty not to exceed $25,000 a day for each violation as provided under section 325(c) Title III.

SUBPART B — REPORTING REQUIREMENTS

372.22 — Covered Facilities for Toxic Chemical Release Reporting

A facility that meets all of the following criteria for a calendar year is a covered facility for that calendar year and must report under 372.30:

(a) Facility has 10 or more full-time employees.

(b) Facility is in Standard Industrial Classification Codes (SIC) 20 through 39 (as in effect January 1, 1987) and meets one of the following criteria:

(1) Facility is an establishment with a primary SIC of 20 through 39.

(2) Facility is a multi-establishment complex where all establishments have primary SIC 20 through 39.

(3) Facility is a multi-establishment complex in which one of the following is true:

(i) Sum value of products shipped and/or produced from those establishments in primary SIC 20-39 is greater than 50% of the total of all products shipped and/or produced from all establishments at the facility.

(ii) One establishment with primary SIC 20-39 contributes more in value of products shipped and/or produced than any other establishment in the facility.

(c) Facility manufactured (including imported), processed, or otherwise used a toxic chemical in excess of an applicable threshold quantity of that chemical as set forth in 372.25.

372.25 — Threshold for Reporting

(a) Threshold amounts, for reporting purposes, of the toxic chemical manufactured or processed for the year, were set as follows:

For calendar year:

1987 — 75,000 pounds.
1988 — 50,000 pounds.
1989 and thereafter — 25,000 pounds.

(b) For chemicals used at a facility, the threshold amount is 10,000 pounds for the calendar year.

(c) Except as provided in 372.38, activities at a facility involving more than applicable threshold amounts, owners or operators must report on all activities involving the chemical at the facility if any threshold is exceeded.

(d) When a facility manufactures, processes, or otherwise uses more than one member of a chemical category listed in 372.65(c) in excess of any applicable threshold for the total volume of all members of the category involved in the applicable activity, the owner or operator must report. The report must cover all activities at the facility involving members of the chemical category.

(e) A facility may process or otherwise use a toxic chemical in a recycle/reuse operation. A determination is to be made if use of a chemical is more than the applicable threshold for the chemical. To make the determination, count the amount of the chemical added to the recycle/reuse operation during the calendar year. If the facility starts up the operation, or contents of the entire recycle/reuse operation are replaced in a calendar year, the amount of the chemical placed into the system at these times is also to be counted.

(f) Chemicals listed in 372.65 with the notation that only persons who manufacture the chemical, or use certain manufacturing methods, are required to report, if such manufacturing is in excess of the threshold applicable to such manufacturing in 372.25. This report needs to account only for the quantity of the chemical manufactured or releases associated with such manufacturing. (Releases associated with subsequent processing or use of the chemical at the facility need not be reported.)

Owners and operators of facilities that solely process or use such a chemical are not required to report for that chemical.

(g) Chemicals listed in 372.65 with notations describing a specific form or color (e.g., fume, dust, solution, friable, or yellow in color), need to be reported only if used in such listed form and in excess of threshold applicable to such activity in 372.25.

The report, if required, needs to account only for the quantity of the chemical in the specific form or color specified in 372.65 and for releases associated with the chemical in that form or color.

Facilities that solely manufacture, process, or use such chemical need not report for that chemical.

(h) Reporting on metal compounds:

For the purpose of determining threshold, as specified in 372.25, the determination is to be based on the total amount of all members of the metal compound category manufactured, processed, or used at the facility.

In completing the release portion of the reporting format for releases of the metal compounds, the owner or operator is only required to account for the weight of the parent metal released. Any contribution to the mass of the release attributable to other portions of each compound in the category is excluded.

372.30 — Reporting Requirements and Schedule

(a) EPA Form R (Form 9350-1) must be completed for each toxic chemical manufactured, imported, processed, or otherwise used in excess of applicable threshold quantity at a covered facility. (See instructions in Subpart E.)

A completed report must be submitted to EPA and to the state in which facility is located.

(b) Owner or operator is required to report on:

(1) Toxic chemical known to be present as a component of a mixture or trade name product that is received, imported, processed, or otherwise used in excess of applicable threshold quantity at the facility as part of the mixture or trade name product.

(2) Toxic chemical is known to be present as a component of a mixture or trade name product:

(i) Owner or operator has been told the chemical identity or Chemical Abstract Service Number (CAS#) and such identity number corresponds with that shown in 372.65; or

(ii) told by supplier that the mixture or trade name product contains a toxic chemical subject to Section 313 of the Act or this Part.

(3) To determine if the toxic chemical component is in excess of applicable threshold quantity, the owner or operator shall consider only that portion of the mixture or trade name product that consists of the toxic chemical together with any other amount of that same chemical involved in the manufacturing, processing, or use at the facility, as follows:

(i) If specific identity and concentration of toxic chemical of the component is known, determine its weight and combine this weight with weight of other quantities of that chemical manufactured, processed, or used at the facility other than as part of a mixture or trade name product. If combined weight is in excess of applicable threshold, report the specific chemical identity and all releases of the chemical on EPA Form R.

(ii) If specific identity is known, but specific concentration is not, and if owner or operator has been told the upper bound concentration of the toxic chemical component, a report is to be made as provided in (3)(b)(i).

(iii) If chemical identity is known, but specific concentration is not, and the owner or operator has not been told the upper bound concentration nor has information been developed on the composition of the chemical, the owner or operator is not required to factor in the chemical component in the mixture or trade name product in calculations for that chemical.

(iv) If told a toxic chemical is present in the mixture or trade name product and concentration of the chemical present is known, but specific chemical identity is not known, determination should be made only for the weight of the toxic chem-

ical. If determined to be in excess of applicable threshold, enter the generic name of the chemical, if known, in reporting releases of the chemical on EPA Form R, in accordance with instructions in Subpart E.

(v) If told a toxic chemical is present in the mixture or trade name product, and told the upper bound concentration, but the specific chemical identity is not known, a determination and report is to be made as provided in paragraph (3)(b)(iv).

(vi) If told a toxic chemical is present in the mixture or trade name product but neither the specific chemical identification or concentration is known, and owner or operator has not been told the upper bound concentration, a report is not required for that chemical.

(c) A covered facility may consist of more than one establishment.

The owner or operator of such a facility at which a toxic chemical is manufactured, processed, imported, or otherwise used in excess of applicable threshold, may submit a separate EPA Form R for each establishment or group of establishments within the facility, provided that activities at all establishments involving the chemical are reported.

If separate reports are filed, then these establishments or group of establishments will be required to file separate EPA Form R reports for all other chemicals subject to reporting at the facility.

(d) Reports must be submitted on or before July 1 for activities which occurred during the previous calendar year. (The first such report, covering activities in 1987, was due July 1, 1988.)

(e) For reports applicable to calendar years 1987, 1988, and 1989 only, the range provided in the reporting form and instructions in Subpart E may be used in reporting releases of specific toxic chemicals to an environmental medium or transfers of waste containing a specific toxic chemical to an off-site location of less than 1,000 pounds.

These ranges may not be used for reports applicable to calendar year 1990 and beyond.

372.38 — Exemptions

(a) De minimums concentrations of a toxic chemical in a mixture.

If a toxic chemical present in a mixture is less than 1% of the mixture, or 0.1% of a mixture if the toxic chemical is a carcinogen as defined in CFR 29.1910.1200(d)(4), the owner or operator is not required to consider the quantity of the toxic chemical in determining whether applicable threshold has been met under 372.25, or in determining releases to be reported under 372.30.

This exemption does not apply to the toxic chemical in a mixture at higher concentrations, manufactured, or otherwise used in excess of applicable threshold quantity.

(b) Articles.

A toxic chemical present in an article need not be considered in determining whether applicable thresholds have been met. Important — Carefully review definition of ''article'' and ''release'' in 372.3 . If a release of a toxic chemical occurs as a result of processing or use of an item, that item does not meet the definition of an ''article.''

(c) Uses.

Chemicals used as defined in this paragraph (c) are not required to be considered in determining whether an applicable threshold quantity has been met:

(1) Use in structural component of the facility.

(2) Use for routine janitorial or facility grounds maintenance. Example: use as janitorial supply, fertilizer, or pesticide similar in type or concentration to consumer product.

(3) Personal use by employees or others at facility of foods, drugs, cosmetics, or other personal items containing toxic chemicals. Included in this ''use category'' — supplies of such products in the facility cafeteria, store, or infirmary.

(4) Use of products for maintenance of motor vehicles operated by the facility.

(5) Use of toxic chemicals present in process water and non-contact cooling water as drawn from the environment or municipal sources, or chemicals present in air used as compressed air or as part of combustion.

(d) Activities in laboratories.

The quantity of chemical used in a laboratory at facility under supervision of a technically qualified individual [as defined in 720.3(ee)] is not required to be considered in determining whether applicable threshold has been met. This exemption does not apply in the following cases:

(1) Specialty chemical production;

(2) Manufacture, processing, or use in pilot plant scale operations; and

(3) Activities conducted outside the above laboratory.

(e) Certain owners of leased property.

Owners whose sole interest is the real estate on which facility is operated are exempt from reporting requirements. This exemption applies to owners of facilities such as industrial parks, all or part of which are leased to persons operating establishments within SIC 20 through 39 where the property owner has no other business interest in the operation of the covered facility.

(f) Reporting by certain operators of establishment on leased property such as industrial parks.

Two or more persons, who do not have any common corporate business interest (including common ownership or control), operate separate establishments within a single facility, each such person shall treat the establishments it operates as a facility for purpose of reporting requirements of this Part.

Note: a common corporate or business interest includes ownership, partnership, joint ventures, ownership of controlling interest in one person by the other, or ownership of a controlling interest in both persons by a third person.

SUBPART C — SUPPLIER NOTIFICATION REQUIREMENTS

372.45 — Notification about Toxic Chemicals

(a) Except as provided in paragraphs (c), (d), and (e) of this section and 372.65, a person who owns or operates a facility or establishment which:

(1) is in SIC 20 through 39,

(2) manufactures or processes a toxic chemical, and

(3) sells or otherwise distributes a mixture or trade name product containing the toxic chemical, to

(i) a facility described in 372.22, or

(ii) to a person who in turn may sell or distribute the mixture or trade name product to a facility described in 372.22

must notify each person to whom the mixture or trade name product is sold or distributed from the facility or establishment in accordance with paragraph (b) of this section.

(b) The notification shall be in writing and include:

(1) a statement that the mixture or trade name product contains a toxic chemical or chemical subject to reporting requirements of section 313 of Title III of SARA and 40 CFR 372;

(2) name of each toxic chemical, and associated Chemical Abstract Service registry number (CAS), if applicable, as set forth in 372.65; and

(3) percent by weight of each toxic chemical in the mixture or trade name product.

(c) Notification shall be provided as follows:

(1) Written notice with at least the first shipment of each calendar year, after January 1, 1989, to a recipient of a mixture or trade name product containing a chemical listed in 372.65.

(2) For chemicals listed in 372.65 with effective date of January 1, 1989 or later, notification will be required beginning with the applicable effective date.

(3) If a change is made to a mixture or trade name product, for which notification was previously provided, by adding, deleting a toxic chemical, or change in percent by weight of a toxic chemical, a revised notification shall be provided with the first shipment of the revised mixture or trade name product to the recipient.

(4) If a person discovers:

(i) a mixture or trade name product previously sold or distributed during the calendar year contains one or more toxic chemicals, and

(ii) notification previously provided did not properly identify the toxic chemical, or accurately present the percent by weight of the toxic chemical, a new notification shall be provided to the recipient within 30 days of the discovery, and identify the shipments of the mixtures or product in the calendar year to which the new notification applies.

(5) If a Material Safety Date Sheet (MSDS) is required to be prepared and distributed for the mixture or trade name product by 29 CFR 1910.1200, notification must be attached to, or incorporated into such MSDS. A notification attached to an MSDS must contain clear instructions that the notification must not be detached, and that any subsequent copying and redistributed copies of the MSDS must also contain or have attached a copy of the notification.

(d) Notifications are not required under following instances:

(1) Mixture or trade name product contains no toxic chemical in excess of the minimum concentration as defined in 372.38 (a),

(2) The product is one of following:

(i) an "article."

(ii) food, drug, cosmetic, alcoholic beverage, tobacco or tobacco product, packaged for distribution to general public.

(iii) consumer product as defined by Consumer Products Safety Act (15 U.S.C. 125 et seq.), packaged for distribution to general public.

(e) If specific identity of toxic chemical is claimed to be a trade secret under 29 CFR 1910.1200, the notice shall contain a generic name descriptive of the toxic chemical.

(f) If specific weight by composition of toxic chemical in mixture or trade name product is considered a trade secret under applicable State law or under the Restatement of Torts section 757, comment b, the notice must contain a statement that the chemical is present in a concentration that does not exceed a specified upper bound concentration value. For example:

A supplier considers the specific concentration of a toxic chemical of 12% to be a trade secret. The notice would indicate the chemical concentration is present in no more than 15% by weight. The upper bound value chosen must be no larger than necessary to adequately protect the trade secret.

(g) A person is subject to the requirements of this section only if he or she has knowledge that a toxic chemical is present in the mixture or trade name product being sold or distributed.

For the purpose of this section, a person has such knowledge if notice has been received from a supplier, as required by this section.

(h) If two or more persons own or operate separate establishments, as described in 372.38(f), within a single facility, each such person shall treat the establishment(s) it operates as a facility for purpose of this section (refer to paragraph (a) of this section for determination of such establishment(s).

SUBPART D — SPECIFIC TOXIC CHEMICAL LISTINGS

372.65 Chemicals and chemical categories to which this Part applies

This section contains three listings:

Paragraph:

(a) Alphabetical order listing of chemicals that have an associated Chemical Abstract Service (CAS) Registry number.

(b) CAS numerical sequence of chemicals in (a).

(c) Chemical categories, listed in alphabetical order, for which reporting is required. These chemical categories do not have CAS numbers.

Each listing identifies effective dates for reporting under 372.30.

(a) Alphabetical Listing.

(b) CAS Number Listing.

(c) Chemical Categories in Alphabetical Order.

SUBPART E — FORMS AND INSTRUCTIONS

372.85 Toxic Chemical Release Reporting Forms and Instructions

(a) Reporting Form

(b) Instructions

EPA Toxic Chemical Release Inventory Reporting Form follows this page.

Form Approved OMB No.: 2070-0093
Approval Expires: 01/91

(Important: Type or print; read instructions before completing form.)

U.S. Environmental Protection Agency

EPA

TOXIC CHEMICAL RELEASE INVENTORY REPORTING FORM

EPA FORM **R**

Section 313, Title III of The Superfund Amendments and Reauthorization Act of 1986

PART I. FACILITY IDENTIFICATION INFORMATION

(This space for EPA use only.)

1.	1.1 Does this report contain trade secret information? ☐ Yes (Answer 1.2) ☐ No (Do not answer 1.2)	1.2 Is this a sanitized copy? ☐ Yes ☐ No	1.3 Reporting Year

2. CERTIFICATION (Read and sign after completing all sections.)

I hereby certify that I have reviewed the attached documents and that, to the best of my knowledge and belief, the submitted information is true and complete and that the amounts and values in this report are accurate based on reasonable estimates using data available to the preparers of this report.

Name and official title of owner/operator or senior management official

Signature | Date signed

3. FACILITY IDENTIFICATION

3.1	Facility or Establishment Name		3.2 This report contains information for: (check one) a. ☐ An entire covered facility. b. ☐ Part of a covered facility.
	Street Address		
	City	County	
	State	Zip Code	
3.3	Technical Contact	Telephone Number (include area code) ( ) –	
3.4	Public Contact	Telephone Number (include area code) ( ) –	
3.5	a. SIC Code	b.	c.
3.6	Latitude: Deg. Min. Sec.	Longitude: Deg. Min. Sec.	
3.7	Dun & Bradstreet Number(s) a.	b.	
3.8	EPA Identification Number (RCRA I.D. No.) a.	b.	
3.9	NPDES Permit Number(s) a.	b.	
3.10	Name of Receiving Stream(s) or Water Body(s) a.		
	b.		
	c.		
3.11	Underground Injection Well Code (UIC) Identification No.		

Where to send completed forms:

U.S. Environmental Protection Agency
P.O. Box 70266
Washington, DC 20024-0266
Attn: Toxic Chemical Release Inventory

4. PARENT COMPANY INFORMATION

4.1	Name of Parent Company
4.2	Parent Company's Dun & Bradstreet No.

EPA Form 9350-1 (1-88)

(Important: Type or print; read instructions before completing form.)

(This space for EPA use only.)

EPA FORM R
PART II. OFF-SITE LOCATIONS TO WHICH TOXIC CHEMICALS ARE TRANSFERRED IN WASTES

1. PUBLICLY OWNED TREATMENT WORKS (POTW)

Facility Name

Street Address

City | County

State | Zip

2. OTHER OFF-SITE LOCATIONS - Number these locations sequentially on this and any additional page of this form you use.

☐ **Other off-site location**

EPA Identification Number (RCRA ID. No.)

Facility Name

Street Address

City | County

State | Zip

Is location under control of reporting facility or parent company? ☐ Yes ☐ No

☐ **Other off-site location**

EPA Identification Number (RCRA ID. No.)

Facility Name

Street Address

City | County

State | Zip

Is location under control of reporting facility or parent company? ☐ Yes ☐ No

☐ **Other off-site location**

EPA Identification Number (RCRA ID. No.)

Facility Name

Street Address

City | County

State | Zip

Is location under control of reporting facility or parent company? ☐ Yes ☐ No

☐ Check if additional pages of Part II are attached.

EPA Form 9350-1 (1-88)

(Important: Type or print; read instructions before completing form.)

(This space for EPA use only.)

EPA FORM R
PART III. CHEMICAL SPECIFIC INFORMATION

1. CHEMICAL IDENTITY

1.1	☐ Trade Secret (Provide a generic name in 1.4 below. Attach substantiation form to this submission.)
1.2	CAS # ☐☐☐☐☐☐ - ☐☐ - ☐ (Use leading zeros if CAS number does not fill space provided.)
1.3	Chemical or Chemical Category Name
1.4	Generic Chemical Name (Complete only if 1.1 is checked.)

2. MIXTURE COMPONENT IDENTITY (Do not complete this section if you have completed Section 1.)

Generic Chemical Name Provided by Supplier (Limit the name to a maximum of 70 characters (e.g., numbers, letters, spaces, punctuation))

3. ACTIVITIES AND USES OF THE CHEMICAL AT THE FACILITY (Check all that apply.)

3.1	Manufacture:	a. ☐ Produce	b. ☐ Import	c. ☐ For on-site use/processing
		d. ☐ For sale/distribution	e. ☐ As a byproduct	f. ☐ As an impurity
3.2	Process:	a. ☐ As a reactant	b. ☐ As a formulation component	c. ☐ As an article component
		d. ☐ Repackaging only		
3.3	Otherwise Used:	a. ☐ As a chemical processing aid	b. ☐ As a manufacturing aid	c. ☐ Ancillary or other use

4. MAXIMUM AMOUNT OF THE CHEMICAL ON SITE AT ANY TIME DURING THE CALENDAR YEAR

☐☐ (enter code)

5. RELEASES OF THE CHEMICAL TO THE ENVIRONMENT

You may report releases of less than 1,000 lbs. by checking ranges under A.1.		A. Total Release (lbs/yr) A.1 Reporting Ranges 0	1–499	500–999	A.2 Enter Estimate	B. Basis of Estimate (enter code)	
5.1 Fugitive or non-point air emissions	5.1a					5.1b ☐	
5.2 Stack or point air emissions	5.2a					5.2b ☐	
5.3 Discharges to water — 5.3.1 ☐ (Enter letter code from Part I Section 3.10 for stream(s).)	5.3.1a					5.3.1b ☐	C. % From Stormwater 5.3.1c
5.3.2 ☐	5.3.2a					5.3.2b ☐	5.3.2c
5.3.3 ☐	5.3.3a					5.3.3b ☐	5.3 3c
5.4 Underground injection	5.4a					5.4b ☐	
5.5 Releases to land — 5.5.1 ☐☐☐ (enter code)	5.5.1a					5.5.1b ☐	
5.5.2 ☐☐☐ (enter code)	5.5.2a					5.5.2b ☐	
5.5.3 ☐☐☐ (enter code)	5.5.3a					5.5.3b ☐	

☐ (Check if additional information is provided on Part IV–Supplemental Information.)

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EPA FORM **R**, Part III (Continued)

6. TRANSFERS OF THE CHEMICAL IN WASTE TO OFF-SITE LOCATIONS

You may report transfers of less than 1,000 lbs. by checking ranges under A.1.	A. Total Transfers (lbs/yr) A.1 Reporting Ranges 0	1–499	500–999	A.2 Enter Estimate	B. Basis of Estimate (enter code)	C. Type of Treatment/ Disposal (enter code)
6.1 Discharge to POTW					6.1b	
6.2 Other off-site location (Enter block number from Part II, Section 2.)					6.2b	6.2c
6.3 Other off-site location (Enter block number from Part II, Section 2.)					6.3b	6.3c
6.4 Other off-site location (Enter block number from Part II, Section 2.)					6.4b	6.4c

(Check if additional information is provided on Part IV–Supplemental Information)

7. WASTE TREATMENT METHODS AND EFFICIENCY

A. General Wastestream (enter code)	B. Treatment Method (enter code)	C. Range of Influent Concentration (enter code)	D. Sequential Treatment? (check if applicable)	E. Treatment Efficiency Estimate	F. Based on Operating Data? Yes	No
7.1a	7.1b	7.1c	7.1d	7.1e %	7.1f	
7.2a	7.2b	7.2c	7.2d	7.2e %	7.2f	
7.3a	7.3b	7.3c	7.3d	7.3e %	7.3f	
7.4a	7.4b	7.4c	7.4d	7.4e %	7.4f	
7.5a	7.5b	7.5c	7.5d	7.5e %	7.5f	
7.6a	7.6b	7.6c	7.6d	7.6e %	7.6f	
7.7a	7.7b	7.7c	7.7d	7.7e %	7.7f	
7.8a	7.8b	7.8c	7.8d	7.8e %	7.8f	
7.9a	7.9b	7.9c	7.9d	7.9e %	7.9f	
7.10a	7.10b	7.10c	7.10d	7.10e %	7.10f	
7.11a	7.11b	7.11c	7.11d	7.11e %	7.11f	
7.12a	7.12b	7.12c	7.12d	7.12e %	7.12f	
7.13a	7.13b	7.13c	7.13d	7.13e %	7.13f	
7.14a	7.14b	7.14c	7.14d	7.14e %	7.14f	

(Check if additional information is provided on Part IV–Supplemental Information.)

8. OPTIONAL INFORMATION ON WASTE MINIMIZATION

(Indicate actions taken to reduce the amount of the chemical being released from the facility. See the instructions for coded items and an explanation of what information to include.)

A. Type of modification (enter code)	B. Quantity of the chemical in the wastestream prior to treatment/disposal: Current reporting year (lbs/yr)	Prior year (lbs/yr)	Or percent change	C. Index	D. Reason for action (enter code)
			%		

EPA Form 9350-1(1-88)

(Important: Type or print; read instructions before completing form.)

(This space for EPA use only.)

EPA FORM R
PART IV. SUPPLEMENTAL INFORMATION

Use this section if you need additional space for answers to questions in Parts I and III. Number or letter this information sequentially from prior sections (e.g., D,E, F, or 5.54, 5.55).

ADDITIONAL INFORMATION ON FACILITY IDENTIFICATION (Part I - Section 3)

3.5	SIC Code		
3.7	Dun & Bradstreet Number(s)		
3.8	EPA Identification Number(s) RCRA I.D. No.)		
3.9	NPDES Permit Number(s)		
3.10	Name of Receiving Stream(s) or Water Body(s)		

ADDITIONAL INFORMATION ON RELEASES TO LAND (Part III - Section 5.5)

Releases to Land	A. Total Release (lbs/yr)	A.1 Reporting Ranges 0	1-499	500-999	A.2 Enter Estimate	B. Basis of Estimate (enter code)
5.5___ (enter code)	5.5___a					5.5___b
5.5___ (enter code)	5.5___a					5.5___b
5.5___ (enter code)	5.5___a					5.5___b

ADDITIONAL INFORMATION ON OFF-SITE TRANSFER (Part III - Section 6)

	A. Total Transfers (lbs/yr)	A.1 Reporting Ranges 0	1-499	500-999	A.2 Enter Estimate	B. Basis of Estimate (enter code)	C. Type of Treatment/ Disposal (enter code)
6.___ Discharge to POTW	6.___a					6.___b	
6.___ Other off-site location (Enter block number from Part II, Section 2.)	6.___a					6.___b	6.___c.
6.___ Other off-site location (Enter block number from Part II, Section 2.)	6.___a					6.___b	6.___c.

ADDITIONAL INFORMATION ON WASTE TREATMENT (Part III - Section 7)

A. General Wastestream (enter code)	B. Treatment Method (enter code)	C. Range of Influent Concentration (enter code)	D. Sequential Treatment? (check if applicable)	E. Treatment Efficiency Estimate	F. Based on Operating Data? Yes	No
7.___a	7.___b	7.___c	7.___d	7.___e %	7.___f	
7.___a	7.___b	7.___c	7.___d	7.___e %	7.___f	
7.___a	7.___b	7.___c	7.___d	7.___e %	7.___f	
7.___a	7.___b	7.___c	7.___d	7.___e %	7.___f	
7.___a	7.___b	7.___c	7.___d	7.___e %	7.___f	

EPA Form 9350-1(1-88)

TOXIC CHEMICAL RELEASE INVENTORY REPORTING FORM

EPA Form R has four parts, printed on five pages, as follows:

Part I. Facility Identification Information

This part asks if a report contains trade secret information, and if it is a "sanitized" report. On this part it is necessary to show, in detail, the physical location of the facility or establishment — including longitude and latitude, name and signature of an authorized individual or manager to certify accuracy of the report, entry of certain related permit numbers, and establishment's SIC.

Part II. Off-Site Locations to which Toxic Chemicals are Transferred in Wastes

Enter name(s) and locations of Publicly Owned Treatment Works (POTW), other Off-Site facilities to which wastes are transferred.

Part III. Chemical Specific Information

On this part, report:

1. Chemical identity (generic name can be shown if trade secret is claimed).
2. Mixture component(s) identity.
3. Activities and uses of the chemical at the facility.
4. Maximum amount of the chemical on site during calendar year.
5. Releases of the chemical to the environment(s): to Fugitive emissions, stack or air emissions, discharges to water, underground injections, releases to land.
6. Transfers of chemical in wastes to Off-Site locations.
7. Waste treatment methods and efficiency.
8. Optional information on waste minimization.

Part IV. Supplemental Information

This part serves as a means of providing additional information, as needed to add in support of entries in the other parts and sections.

Note: Most of the information required in Part I and all of the information required in Part II should be the same for each chemical reported by a specific facility. If such information is identical for two or more chemicals, it is permissible to submit photocopies of these two parts for each such chemical as long as Part I has an original signature on the certification statement (item 2).

Part III must be completed separately for each chemical.

Part IV provides additional space, if needed, to complete information required in the preceding parts.

A completed Form R for a toxic chemical not claimed a trade secret consists of the following completed parts:

Part I (An original signature on certification statement.)

Part II

Part III (Section 8 on waste minimization is optional.)

If needed, Part IV.

A completed report for a toxic chemical claimed trade secret includes all of the above, plus:

A completed trade secret substantiating form:

— A ''sanitized'' version of the report in which sections 1.2 and 1.3 of Part III are left blank, and a generic name for the chemical is shown in section 1.4; and

— A ''sanitized'' version of the trade secret substantiating form.

Trade Secret Claim Substantiating Form:

An EPA Substantiation Form must accompany Claims of Trade Secrecy under The Emergency Planning and Community Right-To-Know Act of 1986. Presented below is background information, an example of the EPA Substantiation Form, and instructions for completion to required form.

Instructions for completing the EPA Trade Secret Substantiating Form:

EPA requires that submitters use only the EPA Substantiating Form; submitter-designed forms will not be accepted. Forms which are not complete may result in denial of trade secret claim.

Be aware that the statute provides that a submitter who fails to provide information required will be subject to a fine.

EPA advises that, for the submitter's own protection, the EPA Substantiating Form be used and completed in its entirety.

The statute (for section 322) establishes a two-phase process in which the submitter must do the following:

1) At the time a report is submitted, the submitter must present a complete set of assertions that (if true) would be sufficient to justify the claim of trade secret, and
2) If the claim is reviewed by EPA, the submitter will be asked to provide additional factual information sufficient to establish the truthfulness of the assertions made at the time the claim was made.

A submitter should also provide descriptive factual statements, if applicable, to support the claim.

EPA SUBSTANTIATION FORM [EPA Form 9510-1(7-88)]

This form consists of five pages on which there are four parts, as follows:

Part 1. Substantiation Category. This section requires submitter to indicate the specific chemical release report to which it relates, and to indicate whether it is a ''sanitized'' or ''unsanitized'' version. (Two versions of this substantiation form will be needed.)

Part 2. The Submitter's Identification and Location. A street address or other physical location identification is to be entered. A post office box number is not acceptable.

Part 3. Responses to Substantiation Questions. This part presents six questions posed by EPA, the responses to which will be assessed by EPA in determining if the trade secret claim is valid and to be approved, or if it should be denied.

The six questions, or information requests, are as follows:

3.1 — What measures have been taken to safeguard the confidentiality of the trade secret information?

3.2 — Has the confidential information been revealed to or discussed with persons other than federal, state, or local officials, or company employees? If so, does an agreement exist to ensure confidentiality of the information?

3.3 — List federal, state, and local entities to which the identity of the chemical has been disclosed, and if trade secrecy claim had been made, and if such claim had been denied.

3.4 — Asks for comment stating why you believe the trade secret information, if revealed, would have specific value to your competitors.

3.5 — Asks for comment, which expands on the previous question, on the extent and nature of harm which could result from disclosure of the trade secret chemical identity.

3.6 — Asks for comment on extent to which the specific chemical is available. A second part of this question asks for comment relating to cost of analysis to determine the presence and quantity of the chemical in a product, article, or waste.

Part 4. The Certification Statement. The statement is to be signed by the owner, operator, or an authorized manager of the company or organization, attesting to the accuracy and truthfulness of the substantiation statement.

EPA Substantiation Form follows this page.

United States Environmental Protection Agency
Washington, DC 20460

EPA

Substantiation To Accompany Claims of Trade Secrecy Under the Emergency Planning and Community Right-To-Know Act of 1986

Form Approved
OMB No. 2050-0078
Approval expires 10-31-90

Paperwork Reduction Act Notice

Public reporting burden for this collection of information is estimated to vary from 27.7 hours to 33.2 hours per response, with an average of 28.8 hours per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Chief, Information Policy Branch, PM-223, U.S. Environmental Protection Agency, 401 M Street, SW, Washington, DC 20460; and to the Office of Information and Regulatory Affairs, Office of Management and Budget, Washington, DC 20503.

Part 1. Substantiation Category

1.1 Title III Reporting Section (check only one)

☐ 303 ☐ 311 ☐ 312 ☐ 313

1.2 Reporting Year 19 _____

1.3 Indicate Whether This Form Is (check only one)

1.3a. ☐ **Sanitized**

(answer 1.3.1a below)

1.3.1a. Generic Class or Category

1.3b. ☐ **Unsanitized**

(answer 1.3.1b. and 1.3.2b. below)

1.3.1b. CAS Number

☐☐☐☐☐☐ – ☐☐ – ☐

1.3.2b. Specific Chemical Identity

Part 2. Facility Identification Information

2.1 Name

2.2 Street Address

2.3 City, State, and ZIP Code

2.4 Dun and Bradstreet Number

☐☐ – ☐☐☐ – ☐☐☐☐

Part 3. Responses to Substantiation Questions

3.1 Describe the specific measures you have taken to safeguard the confidentiality of the chemical identity claimed as trade secret, and indicate whether these measures will continue in the future.

3.2 Have you disclosed the information claimed as trade secret to any other person (other than a member of a local emergency planning committee, officer or employee of the United States or a State or local government, or your employee) who is not bound by a confidentiality agreement to refrain from disclosing this trade secret information to others?

☐ **Yes** ☐ **No**

3.3 List all local, State, and Federal government entities to which you have disclosed the specific chemical identity. For each, indicate whether you asserted a confidentiality claim for the chemical identity and whether the government entity denied that claim.

Government Entity	Confidentiality Claim Asserted		Confidentiality Claim Denied	
	Yes	No	Yes	No

EPA Form 9510-1 (7-88) Page 2 of 5

3.4 In order to show the validity of a trade secrecy claim, you must identify your specific use of the chemical claimed as trade secret and explain why it is a secret of interest to competitors. Therefore:

(i) Describe the specific use of the chemical claimed as trade secret, identifying the product or process in which it is used. (If you use the chemical other than as a component of a product or in a manufacturing process, identify the activity where the chemical is used.)

(ii) Has your company or facility identity been linked to the specific chemical identity claimed as trade secret in a patent, or in publications or other information sources available to the public or your competitors (of which you are aware)?

☐ **Yes** ☐ **No**

If so, explain why this knowledge does not eliminate the justification for trade secrecy.

(iii) If this use of the chemical claimed as trade secret is unknown outside your company, explain how your competitors could deduce this use from disclosure of the chemical identity together with other information on the Title III submittal form.

3.4 (iv) Explain why your use of the chemical claimed as trade secret would be valuable information to your competitors.

3.5 Indicate the nature of the harm to your competitive position that would likely result from disclosure of the specific chemical identity, and indicate why such harm would be substantial.

3.6 (i) To what extent is the chemical claimed as trade secret available to the public or your competitors in products, articles, or environmental releases?

3.6 (ii) Describe the factors which influence the cost of determining the identity of the chemical claimed as trade secret by chemical analysis of the product, article, or waste which contains the chemical (e.g., whether the chemical is in pure form or is mixed with other substances).

Part 4. Certification (Read and sign after completing all sections)

I certify under penalty of law that I have personally examined the information submitted in this and all attached documents. Based on my inquiry of those individuals responsible for obtaining the information, I certify that the submitted information is true, accurate, and complete, and that those portions of the substantiation claimed as confidential would, if disclosed, reveal the chemical identity being claimed as a trade secret, or would reveal other confidential business or trade secret information. I acknowledge that I may be asked by the Environmental Protection Agency to provide further detailed factual substantiation relating to this claim of trade secrecy, and certify to the best of my knowledge and belief that such information is available. I understand that if it is determined by the Administrator of EPA that this trade secret claim is frivolous, EPA may assess a penalty of up to $25,000 per claim.

I acknowledge that any knowingly false or misleading statement may be punishable by fine or imprisonment or both under applicable law.

4.1 Name and official title of owner or operator or senior management official	
4.2 Signature *(All signatures must be original)*	4.3 Date Signed

BILLING CODE 6560-50-C

A. GENERAL SAFETY PROGRAM

STEP 5

Although the Occupational Safety and Health Administration does not require an employer to establish a general safety program, voluntary compliance to such a preliminary program demonstrates evidence of good faith and could prove helpful to an employer during a scheduled inspection.

Through an effective safety program, management may assign responsibility for safety and be sure performance meets that responsibility. To achieve these results, each firm should develop as complete a safety program as possible. Such a program should include the following:

- A Safety Coordinator;
- Safety Committees;
- Regularly scheduled Safety Meetings;
- A written Management Safety Policy; and
- General Safety Rules designed to meet all OSHA guidelines.

In this section you will find detailed instructions on how such an on-going safety program can be established.

SAFETY COORDINATOR

Appoint a key person to assume the responsibility for developing and implementing your complete Safety Program. A safety representative should also be named. The Safety Coordinator should:

1. coordinate safety activities throughout the company;
2. keep and analyze all accident reports;
3. conduct educational activities for all supervisors and employees;
4. conduct activities to maintain interest of employees, using safety bulletins, posters, and contests;
5. investigate accidents and near accidents;
6. plan and direct internal safety inspections;
7. check for compliance for federal, state, and city safety regulations;
8. issue regular reports showing accident trends and safety performance;
9. serve on safety committee; and
10. serve in a staff capacity, without line authority.

Enter the name of your Safety Coordinator below:

_____

SAFETY COMMITTEES

The purpose of the Safety Committee is to maintain/improve workplace safety and to create and maintain employee interest in safety. To accomplish these objectives, management must form committees to establish safety policies, perform inspections, see that the necessary corrections are made, and conduct safety training of all employees. Through such committee action, improvements in the work environment and in work practices can be facilitated.

Ideally, the Safety Committee should have a minimum of two to three members; represent management, supervisors, and employees; and meet at least every 30 days. The Safety Committee should have the following duties:

1. Development of safety rules and programs for all employees;
2. Review of any accidents that occur;
3. Appoint inspection and accident investigation committees;
4. Review and plan action on safety suggestions from employees;
5. Check any operational changes or new construction to be sure that all safety regulations are met;
6. Delegate employees to investigate accidents, make hazard inspections, and report the results to the Safety Committee;
7. Plan future activities to generate interest in safety; and
8. Plan General Safety Meetings.

Enter the names of the members of your Safety Committee:

NAMES

_____

_____

_____

_____

_____

SAFETY MEETINGS

General safety meetings should be planned regularly so that all employees will be trained and educated in safe working procedures. A chairman for the general meetings should be appointed by the Safety Committee. The duties of the chairman should include the following:

1. Arranging a suitable place for the meeting.
2. Notifying all employees as to the time and place of the meeting.
3. Making sure the program has been completed for the meeting.
4. He or she should also make sure that the inspection committees have completed their reports.

A secretary should be appointed to keep minutes for the record. An employee from the office might be considered. The secretary's duties should include:

1. reading the minutes from the last meeting;
2. calling the roll;
3. taking notes during the meeting;
4. preparing minutes and furnishing the Safety Committee with a copy; and
5. preparing a status report on old and new recommendations.

In the spaces below, enter the dates, times, and places of your general safety meetings:

_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

Two employees from the general meeting should be delegated to act as an Inspection Committee, and membership should be rotated regularly. The duties of the Inspection Committee should include the following:

1. Before each meeting, a survey should be made of the entire premise to determine physical and fire hazards, as well as unsafe practices.
2. A written report of these findings should be prepared for the Safety Committee, as well as a personal oral report to the general safety meeting.

The Investigative Committee should also be appointed from the employee group, with rotating membership. Its duties should include:

1. handling investigations of any accident or of any unsafe condition or act that has caused injury;
2. a report of findings to the Safety Committee; and
3. a report to the general safety meeting about the action taken to prevent recurrence of the same kind of accident.

The following procedure should be followed in conducting a safety meeting:

1. Call the meeting to order;
2. Have roll called;
3. Introduce visitors;
4. Have secretary read the minutes from the last meeting;
5. Call for unfinished business;
6. Conduct a review of accidents;
7. Have the Investigation Committee report its findings as to prevention of similar accidents;
8. Have guests, members, management, or employees give talks on safety;
9. Have Inspection Committee give its report;

10. Present the status of old recommendations;
11. Open the meeting to suggestions from the floor; and
12. Adjourn meeting.

WRITTEN SAFETY POLICY

The management of every business should prepare and publish a Management Policy on Safety. This should be typed on company stationery and posted or distributed so all employees are aware of management's attitude toward safety. It is also advisable to prepare the safety policy in the form of a leaflet or incorporate it in an employee manual to be distributed to each employee. Some companies require new employees to sign a statement indicating they have read and understand the company safety policy and safety rules. The signed statement is then kept in the employee's personnel file. See page 5-10d for the recommended ''sign-off'' statement.

Use the sample ''Written Policy'' which follows, or develop one in your own words, and post it on your bulletin board along with General Safety Rules you should establish for your company. For guidance, we provide sample written policy ideas, an example of a typical company safety policy, plus a series of recommended General Safety Rules. Select the rules that apply to your type of operation, and add any other that may be needed by your company.

Because some states require posting of English and Spanish versions of safety rules and related information, we have translated the essential material and incorporated it into this section of your manual. The English version is on pages 5-5 through 5-8. The Spanish version is on pages 5-9 through 5-10c.

SAMPLE MANAGEMENT SAFETY POLICY

(Company Letterhead)

Management's Policy on Safety

As corporate officials, we consider accident prevention to be of prime importance. Accident control involves the safety and well-being of our employees and the public, in addition to affecting costs and profits.

Management has every desire to provide a safe working environment for its employees. To accomplish this, management feels there is nothing more important than making certain that:

1. You are provided with all reasonable safeguards to ensure safe working conditions.
2. You are provided with neat, clean, safe, attractive, and healthful working conditions.
3. We maintain all equipment, tools, and machines in good repair.
4. We study and develop safe work methods, and train employees in these methods.
5. We comply with federal, state and local laws regarding accident prevention and working conditions.

Management recognizes that more than safety is involved, because the existence of accident hazards is proof of a wasteful, inefficient operation. Accidents lead to complaints, dissatisfaction, interference with work plans, and loss of good will.

The success of our Accident Prevention Program depends on the sincere, constant, and cooperative effort of all employees and their active participation and support. If you see a hazard, report it immediately; the life you save may be your own.

_____

Signature

SAMPLE WRITTEN SAFETY POLICY

(Company Letterhead)

From:_____, President

Subject: **COMPANY SAFETY AND HEALTH POLICY**

The personal safety and health of each employee of this company is of primary importance. The prevention of occupationally-induced injuries and illnesses is of such consequence that it will be given precedence over operating productivity whenever necessary. To the greatest degree possible, management will provide all mechanical and physical facilities required for personal safety and health, in keeping with the highest standards.

We will maintain a safety and health program conforming to the best practices of organizations of this type. To be successful, such a program must embody the proper attitudes toward injury and illness prevention on the part of both supervisors and employees. It also requires cooperation in all safety and health matters, not only between supervisor and employee, but also between each employee and his fellow workers. Only through such a cooperative effort can a safety record in the best interest of all be established and maintained.

Our objective is a safety and health program that will reduce the number of disabling injuries and illnesses to a minimum, not merely in keeping with, but surpassing, the bext experience of other operations similar to ours. Our goal is **ZERO** accidents and injuries. Our safety and health program will include:

1. Providing mechanical and physical safeguards to the maximum extent that is possible.
2. Conducting a program of safety and health inspections to find and get rid of unsafe working conditions or practices; to control health hazards; and to comply fully with the safety and health standards for every job.
3. Training all employees in good safety and health practices.
4. Providing necessary personal protective equipment and instructions for its use and care.
5. Developing and enforcing safety and health rules; requiring that employees cooperate with these rules as a condition of employment.
6. Investigating, promptly and thoroughly, every accident to find out what caused it and to correct the problem so that it won't happen again.
7. Setting up a system of recognition and awards for outstanding safety performance.

We recognize that the responsibilities for safety and health are shared:

a. As your employer we accept the responsibility for leadership of the safety and health program, and for its effectiveness and improvement, and for providing the safeguards required to ensure safe conditions.

b. Our supervisors are responsible for developing the proper attitudes toward safety and health in themselves and in those they supervise; and for ensuring that all operations are performed with the utmost regard for the safety and health of all personnel involved, including themselves.

c. As employees, you are responsible for wholehearted, genuine cooperation with all aspects of the safety and health program —including compliance with all rules and regulations, and for continuously practicing safety while performing your duties.

_____

Signature

GENERAL SAFETY RULES

1. In case of sickness or injury, no matter how slight, report at once to your supervisor for First Aid. Never attempt to treat your own or another worker's injury or try to remove foreign particles from the eye.
2. Safety devices are for your protection. Never operate your machine unless all guards provided are in place.
3. Guards must never be removed except when necessary to make adjustments or repairs, and they should be replaced immediately upon completion of work. If a guard is not in its proper position, report this at once to your supervisor.
4. Employees must remain in their own departments unless called away on business or in the regular course of their employment.
5. **RUNNING** on the premises is **NOT PERMITTED**.
6. Horseplay, throwing objects, scuffling, and fooling around are very dangerous and will not be tolerated.
7. Never distract the attention of another employee, as you might cause injury.
8. Illegal drugs and liquor will not be permitted on the premises at any time.
9. Jewelry, rings, bracelets, watch chains, key chains, etc., shall not be worn, for these objects might catch in machines, causing serious accidents such as the loss of fingers or hands.
10. Gloves must not be worn when operating machinery unless their use has been approved by your supervisor.
11. Loose ties or torn clothing must not be worn around machinery. It is suggested that sleeves be cut off at the elbow.
12. Before using any ladder, make sure it has good safety feet, and is free from cracks, broken rungs, or other defects. When there is any danger of slipping, have another worker hold the ladder.
13. Never use makeshift or defective scaffolding, rigging, or stages.
14. Never climb through, over, under, or between railroad cars. Wait until the train passes or walk around the end of the train, giving yourself plenty of room for safety.
15. Do not attempt to lift or push objects that may be too heavy for you. **ASK FOR HELP** when you need it. Learn to lift the right way to avoid strains: bend your knees; keep your body erect; then push up with your legs. This is the easiest and the safest way.
16. Shut down your machine before cleaning, adjusting, or repairing. Lock and tag the machine.
17. Never oil machines while they are in motion except where points of oiling are so located or guarded that you are not subject to contact with moving parts.
18. Never use your finger for removing chips from machines. Use a brush or a hook.
19. Never use defective chisels, sledge hammers, punches, wrenches, or other tools. Flying chips from tools with mushroomed or split heads cause many injuries. Exchange or see that the defective tools are repaired.
20. *If you are provided with eye protection, you are expected to wear it.*

21. Never operate any machine, crane, tractor, elevator, or other piece of moving equipment unless you have permission from your supervisor.
22. Caps should be worn around moving machinery by any employee with long hair.
23. If you are working where there are heavy fumes or dust, you are expected to wear the respirators provided for your protection. *In some cases, a lifeline and an observer may be required.*
24. Keep the area around you clean. Put all oily water, rubbish, and papers in the containers provided for those purposes.
25. Learn the location of all the fire exits and alarm boxes in your department.
26. Pile material, trucks, skids, racks, crates, boxes, ladders, and other equipment so that they do not block aisles, exits, fire fighting equipment, alarm boxes, electric lighting, power panels, etc. *FIRE DOORS MUST BE KEPT CLEAR.*
27. Learn the location and proper use of fire fighting equipment in your department. Under no circumstances use a pail of water where extinguishers are provided.
    a. For all electrical fires, use only extinguishers approved for Class C fires (carbon dioxide or dry chemical). *NEVER USE ANYTHING ELSE*, as the danger of electrocution exists.
    b. For common fires, such as with rubbish, paper, wood, rags, etc., use water, foam, or soda-acid extinguishers.
    c. For fires in flammable liquids, use foam type extinguishers or other special extinguishers provided for that purpose.
28. Slippery floors cause falls. Always keep the floor clean.
29. If you see someone working carelessly and liable to be hurt, warn and advise them to work carefully.
30. Protect your feet and head by keeping your shoes and hard hat (especially the soles of the shoes and the liner of the hard hat) in good shape. Wear safety-toe-capped shoes to prevent serious toe injuries.
31. Unless you are an electrician, never tamper with electrical circuits or switches.
32. Always obey all warning signs.
33. Read the Safety Bulletins that are posted, for they will help you do your part in the accident prevention drive.
34. Never take short cuts through dangerous places.
35. If you don't know the safe way, stop and find out.

SAMPLE MANAGEMENT SAFETY POLICY (SPANISH)

(Membrete de la Compañía)

Póliza de Seguridad de la Empresa

Como directores unidos consideramos que la prevención de los accidentes es de primer importancia. El controlar los accidentes envuelve la seguridad y bienestar de nuestros empleados y el público además de que afecta los costos y las ganancias.

La empresa desea mucho darles a sus empleados un ambiente seguro de trabajo. Para lograrlo, creemos que no hay nada que importe más que el estar seguro de que:

1. Estén proporcionadas todas las salvaguardias para asegurar que haya buenas condiciones de trabajo.
2. Estén proporcionadas condiciones de trabajo que sean aseadas, limpias, seguras, atractivas, y sanas.
3. Mantengamos todo el equipo, todas las herramientas, y todas las máquinas en buen estado.
4. Estudiemos y desarrollemos métodos seguros de trabajo, y que métodos se los enseñemos a los empleados.
5. Obremos de acuerdo con las leyes federales, de nuestro estado, y las locales, respecto a las condiciones laborales y a la prevención de accidentes.

La empresa reconoce que se trata de más que la seguridad personal, pues la existencia de cualquier peligro de un accidente es evidencia de trabajo derrochador y de mal rendimiento.

El éxito de nuestro Programa del Impedir los Accidentes depende del sincero, fiel, y cooperativo esfuerzo de todo empleado y su participación y su apoyo activos. Si ve un peligro, relátelo en seguida; la vida que salve puede ser la suya.

_____

Signature

SAMPLE WRITTEN SAFETY POLICY (SPANISH)

(Company Letterhead)

De_____, Presidente

Asunto: PÓLIZA DE LA SEGURIDAD Y SALUD DE LA COMPAÑIA

La seguridad y la salud personales de cada empleado de esta compañia es de importancia primaria. Las medidas de precaución contra lesiones y enfermedades causadas por el trabajo recibirán mayor atencion sobre la productividad maniobrera cuando sea necesario. En todo lo que pueda, la dirección proporcionará todas las facilidades mecánicas y corporales exigidos para la seguridad y la salud personales según las mas altas reglas. Mantendremos un programa de seguridad y salud conforme a las prácticas mejores de los establecimientos de este tipo. Para lograrse, tal programa debe incorporar justas actitudes de parte de la superintendencia y los empleados hacia las medidas de precaución contra lesiones y enfermedades. En todos los asuntos de seguridad y salud, se hace falta también cooperación no solamente entre el superintendente y el empleado, sino también entre los empleados mismos. Para establecer y proteger un historial de seguridad para todos, es imprescindible mantener tal esfuerzo cooperativo. Nuestro objectivo es un programa de seguridad y salud que reducirá las lesiones y enfermedades incapacitantes hasta lo mínimo, no solamente de acuerdo con, sino también superando la mejor experiencia de otras industrias como la nuestra. Nuestra meta es no tener NINGÚN accidente ni lesión. Nuestra programa de seguridad y salud incluirá:

1. Suministrar la mayor cantidad posible de salvaguardias mecánicas y corporales.
2. Conducir un programa de inspecciones de seguridad y salud para encontrar y deshacernos de toda condición o prática del trabajo que sea insegura; controlar los riesgos de salud; y obrar completamente de acuerdo con las normas de seguridad y salud para todo el trabajo.
3. Enseñar a todos los empleados las buenas práticas de seguridad y salud.
4. Suministrar el equipo necesario para la protección personal e instrucciones para su uso y cuidado.
5. Desarrollar y hacer cumplir las reglas de seguridad y salud; exigir que los empleados cooperen con éstas como una condición del empleo.
6. Investigar puntualmente y a fondo todo accidente para averiguar la causa y corregir el problema para que no vuelva a ocurrir.
7. Crear un sistema del reconocer y de premios por el sobresaliente ejecución de la seguridad.

Reconocemos que se comparten las responsibilidades para seguridad y salud:

a. Como su jefe, nosotros aceptamos la responsibilidad de la jefatura del programa de seguridad y salud, de su eficacia, y aprovechamiento, y de suministrar las salvaguardias exigidas para asegurar que las condiciones sean seguras.

b. Nuestros superintendentes son responsable del desarrollar las justas actitudes hacia la seguridad y salud de ellos mismos y de los que dirigen; y de asegurar que todo el trabajo se ejecuta con la mayor consideración de la seguridad y salud de todo el empleado, hasta ellos mismos.

c. Como empleados ustedes son responsables de una sincera y franca cooperación con todas las fases del programa de seguridad y salud – incluso el conformar con todas las reglas y las regulaciones – y de ejercitar continuamente la seguridad cuando ejecutan sus quehaceres.

_____

Signature

GENERAL SAFETY RULES (SPANISH)

REGLAS GENERALES DE SEGURIDAD

1. En el caso de enfermedad o lesión, la menor que sea, relátela en seguida a su capataz para la Cura de Urgencia. Bajo ninguna circunstancia debe tratar a si mismo ni a su compañero ni quitarle corpúsculos del ojo.
2. Los aparatos de seguridad son para su protección. No maneje nunca una máquina sin que estén puestas todas las salvaguardias proporcionadas.
3. No se quitarán nunca las salvaguardias, excepto cuando sea necesario para hacer arreglo o reparación, y se debe reponerlas tan pronto se termine el trabajo para el cual se quitarán.
4. Los empleados se quedarán en sus propios departamentos a no ser que se les manden a otra parte por negocio o el curso normal de su empleo.
5. NO SE PERMITE CORRER en el local mismo.
6. La payasada, el echar cosas, el luchar y la broma son muy peligrosos y no se les tolerarán.
7. No distraiga nunca la atención de un otro empleado, pues puede causar su lesión.
8. No se permite bebidas alcohólicas en el local mismo en ningún momento.
9. No se llevará joyería, anillos, pulseras, cadenas de relojes, cadenas para llaves, etc., porque éstos pueden engancharse en las máquinas y causar graves accidentes como la pérdida de los dedos o las manos.
10. No se llevará guantes cuando se maneja cualquier máquina, a no ser que su uso esté aprobado por el capataz.
11. No se llevará largos lazos, corbatas, ni ropa floja, andrajosa, o desgarrada alrededor de las máquinas que están en movimiento. Se aconseja que las mangas estén cortadas al codo.
12. No esté de pie ni ande nunca debajo de una grúa o bulto que esté en la montacargas. Obedezca al señor que tenga el silbo; escuche al timbre de la grúa u otro aparato de señales.
13. Use el aire comprimido solamente para el trabajo para el cual fue destinado. No se limpie la ropa con esto; no lo aje, no lo sople nunca contra nadie, puesto que puede entrar en su cuerpo y matarlo.

GENERAL SAFETY RULES (SPANISH) (cont'd.)

14. Antes de usar cualquier escalera, esté seguro de que tenga ella buenos pies de seguridad y que no tenga griestas, travesanos rotos, y otros defectos. Cuando es necesario impedir el deslizar, haga que un empleado sostenga la base de la escalera.
15. No use nunca ningún andamio, equipo, ni plataforma que sea provisional o defectivo.
16. No trepe nunca por, sobre, debajo de, ni entre los coches de un tren. Espere a que pase el tren o ande alrededor de su extremo con bastante espacio para la seguridad.
17. No trate de levantar o empujar objetos que le pueden ser demasiado pesados. Pida ayuda cuando le haga falta. Aprenda a levantar en manera correcta para evitar las torceduras: doble las rodillas; mantengase derecho; y empuje hacia arriba con las piernas. Es la manera mas fácil y segura.
18. Cierra la máquina antes de limpiar, ajustar, o reparar. Ciérrela con llave y péguele un marbete.
19. No lubrique nunca las máquinas cuando estén en movimiento salvo en los puntos de lubricar, y siempre que usted no esté en contacto con las partes en movimiento.
20. Nunca use los dedos para quitarle astillas a la máquina. Use un cepillo o un gancho.
21. Nunca use escoplos, cinceles, acotillos, martillos, punzones, llaves u otras herramientas que estén defectuosas.
22. Si le suminstran protección para los ojos, se espera que la use.
23. Nunca use ninguna máquina, grúa, tractor, montacargas ni otro equipo que se mueve sin que tenga la autorización de su capataz.
24. Las mujeres y los hombres que tienen el pelo largo deben llevar gorras.
25. Si trabaja en donde hay humo o polvo denso, se espera que se pongan los aparatos respiratorios que le son suministrados para su protección. En algunos casos se hacen falta cuerdas salvavidas y un observador.
26. Mantenga limpios sus locales. Tire toda agua aceitosa, basura y papel en los recipientes suministrados para este propósito.
27. Sepa donde se encuentran todas las salidas de incendio y las cajas de avisador de incendios en su departamento.

GENERAL SAFETY RULES (SPANISH) (cont'd.)

28. Amontone el material, los carros, los patinajes, los estantes, las jaulas, las cajas, las escaleras, y otra equipo, para que no obstruyan las naves, las salidas, el equipo de apagafuegos, los avisadores de incendio, la iluminación eléctrica, y el panel generado, válvulas, etc. MANTENGA LIBRES LAS PUERTAS DE INCENDIO.
29. Aprenda la localidad y el uso del equipo de apagafuegos en su departamento. No use bajo ninguna circunstancia un cubo de agua donde hay un apagafuegos.
    a. Para todo incendio eléctrico, use los apagafuegos aprobados para los incendios "Class C" (dioxido de carbono, o químico seco). NO USE NUNCA OTRA COSA, ya que se puede electrocutar si lo hace.
    b. Para los insendios comunes, como con basura, papel, madera, trapos, etc., use apagafuegos de agua, espuma, o ácido de soda.
    c. Para incendios en líquidos inflamables, use apagafuegos de espuma u otros apagafuegos especiales suministrados para ese propósito.
30. Un suelo resbaladizo causa caídas. Mantenga limpios los suelos.
31. Si ve a alguien que trabaja negligentemente y que se puede dañar, avísele que trabaje con más cuidado.
32. Protéjase los pies y la cabeza manteniendo los zapatos y el casco duro (especialamente las suelas de los zapatos y el forro del casco) en buen estado. Use zapatos con las puntas cubiertas para impedir lesiones graves de los dedos.
33. A no ser que sea usted electricista, no manosee los circuitos o las llaves eléctricas.
34. Obedezca todo letrero de aviso.
35. Lea los Comunicados de Seguridad. Le ayudaran a participar en la campaña de la prevención de accidentes.
36. No tome atajo por lugares peligrosos.
37. Si no sabe la manera segura, pare y entérese.

SAMPLE SIGN-OFF STATEMENTS FOR EMPLOYEES AND FOREMEN/SUPERVISORS

I have read and understand the company safety policy and safety guidelines and agree to follow the safety rules it contains.

Employee signature _____

Date _____

I have instructed the above employee in the safe working practices for

_____

(describe job, operation, activity)

Supervisor's or
foreman's signature _____

Date _____

SIGN-OFF STATEMENT (SPANISH)

He leído y comprendo la póliza y las normas de seguridad de esta compañia. Conformo con las reglas que contiene y las seguiré.

Firma del empleado _____

Fecha _____

He instruído antedicho empleado de las prácticas seguras del trabajo en

_____

(describa el empleo, la operación, o la actividad)

Firma del superintendente
o el capataz _____

Fecha _____

B. EDUCATION AND TRAINING

Some employees work safely in dangerous and hazardous conditions, while other employees have accidents performing jobs that are quite safe. *TRAINING EMPLOYEES IS THEREFORE NECESSARY FOR A SAFETY PROGRAM TO BE EFFECTIVE.*

Simply ordering employees to work safely doesn't necessarily mean that they will. In order for management to achieve stated objectives, namely to provide for the safety of employees, it is necessary to educate both the supervisors and the employees to do their jobs properly. The supervisor must be able to train the employee on how to work safely, and management must educate the supervisor in the proper safety training techniques. Therefore, the following kinds of education programs should be conducted:

- Job safety analysis;
- Training of supervisors;
- Training of employees; and
- Regularly scheduled classes in safety, first aid, and fire control.

TRAINING OF SUPERVISORS

A formal safety course of instructions is required to establish desired attitudes in supervisors and to impart the necessary information about safety.

All supervisors should complete a Supervisor's Basic Course in Safety. This training will increase the ability of a supervisor to perform a job from the standpoint of handling employees, efficiency or operation, and safety performance.

The following course will provide the training required to accomplish these objectives. Assign the topics on this list to individual supervisors. Then enter the supervisors' names in the appropriate columns, with the dates, times, and places for them to conduct the lectures.

OCCUPATIONAL SAFETY AND HEALTH PROGRAM
MANAGEMENT TRAINING SCHEDULE

Topic	Lecturer	Date and Time	Place of Meeting
Introduction			
Industrial Loss Prevention			
Organization and Committees			
Supervisor's Responsibility in Loss Prevention			
Inspection and Control Procedures			
Removing the Hazard from the Job			
Human Factors Engineering			
Human Behavior and Industrial Loss Prevention			
Loss Prevention Training for Employees for Safe Performance			
Maintaining Interest in Loss Prevention and Motivating Employees to Work Safely			
Publicizing Loss Prevention			

MANAGEMENT TRAINING SCHEDULE (Continued)

Topic	Lecturer	Date and Time	Place of Meeting
Accident Record & Injury Rates			
Accident Investigation, Analysis and Costs			
Results of Accidents (The Nature and Causes) and How to Prevent Basic Types			
Workers' Compensation Insurance			
Sources of Help (How to Find Answers to Your Loss Prevention Problems)			
Psychological Factors in Loss Prevention			
Layout of Buildings			
Building Construction & Maintenance			
Boilers & Unfired Pressure Vessels			
Principles of Materials Handling & Storage			
Hoisting Apparatus and Conveyors			
Elevators and Plant Railways			
Powered Industrial Trucks			

MANAGEMENT TRAINING SCHEDULE (Continued)

Topic	Lecturer	Date and Time	Place of Meeting
Ropes, Chains and Slings			
Principles of Guarding and Transmission Guards			
Cold Forming & Repairing of Metals			
Machine Tools			
Woodworking Machinery			
Hot Working of Metals			
Local Exhaust Systems			
General and Comfort Ventilation			
Welding and Cutting			
Hand & Portable Power Tools			
Preventing Falls, Overexertion, and Exposure Accidents			
Electrical Hazards			
Scaffolding, Ladders & Platforms			

MANAGEMENT TRAINING SCHEDULE (Continued)

Topic	Lecturer	Date and Time	Place of Meeting
Flammable & Combustible Liquids			
Fire Loss Control			
Fire Extinguishment & Control (Proper Use of Fire Extinguishers, etc.)			
Planning for Emergencies			
Personal Protective Equipment (Eye Protection, etc.)			
Industrial Sanitation and Personnel Facilities			
Industrial Hygiene			
Elements of Toxicology			
Industrial Noise			
Motorized Equipment			
Job Loss Prevention Analysis			
Job Loss Prevention Observations			
Handling the Loss Prevention Problem Employee			

JOB SAFETY ANALYSIS

Safety on the job is a personal matter between each worker, machine, tool, materials, process and procedure. Only when the individual worker has a thorough understanding of all the elements that make up a job, including all potential hazards, will the worker have appreciation for exercising a safety minded attitude. Safety has to be made an integral part of job procedure.

PREPARING AND USING THE JOB SAFETY ANALYSIS FORM

Experienced safety directors, plant managers and personnel directors, know the importance of training workers so they thoroughly know every step involved in each job – every step in a manufacturing process. Workers should be made familiar with ALL known and recognizable hazards that may be present in the equipment used, the materials handled, and the conditions they may encounter. A carefully documented "Job Safety Analysis Sheet," prepared "on-the-job," while observing how each stage and each step of the job or process is actually performed, becomes the basic text model and guide for job-process training.

The Job Safety Analysis form is best completed by first line supervisors working with employees on-the-job in your own plant. This assures that your special procedures and job methods are understood and followed. Key elements to be included are as follows:

1. Job title and description
2. Name of supervisor or department head
3. Job location
4. Machines, tools, equipment to be used
5. Materials or compounds to be used
6. Job procedure
7. Potential health/injury hazards
8. Protective equipment, clothing, devices required
9. Precautionary or safety practices to be followed
10. How, when, and to whom problems are to be reported

The Job Safety Analysis Form provided in this manual can be adapted to most any job situation. If your operations and procedures are more complex (or simpler) you may want to alter the form to suit your needs or design a totally different form.

After identifying the specific job, its location, and the responsible supervisor in the space provided, start preparation – in draft form first. Avoid "stage setting" the observations. It is important that the employee goes through

JOB SAFETY ANALYSIS

JOB TITLE / DESCRIPTION	LOCATION / DEPARTMENT	PREPARED BY: Harley J Peterson	DATE: 7/9/79
DRILLING MACHINE OPERATIONS	Machine Shop "B" Building #4	SUPERVISOR R.G. WILLIAMS	

KEY JOB PROCESS STEPS	TOOLS / MATERIALS USED	POTENTIAL HAZARDS: CONDITIONS OR ACTIONS WHICH COULD CAUSE AN INJURY / AFFECT HEALTH	RECOMMENDED SAFE PRACTICES: PERSONAL PROTECTIVE DEVICES, SPECIAL CLOTHING, PROCEDURES
1. OBTAIN MATERIAL	Tote boxes or con-containers	Strains from lifting or handling parts;	Exercise correct lifting practices;
		Injuries to fingers or hands caught in pinch points, or cuts caused by sharp edges	Wear hand protection and / or use mechanical lifting aids.
2. MOVING MATERIALS TO TO THE JOB	Cart, truck or mechanical lift	Strains from pushing or pulling, falling, slipping, tripping; hand or body caught between objects	Get help to move heavy or bulky parts. Keep work area clear and work surfaces smooth. Keep aisles free of obstructions;
3. SET-UP	Drill press, drills, related equipment	Unguarded belt or pulleys;	Provide guards for belts, pulleys, exposed moving parts;
		Unsecured machines or parts;	Secure machine to floor or base;
		Lighting poor, area around machine cluttered; machine close to traffic;	Provide adequate lighting. Clear area near machine. Set up barrier if needed.
		Controls awkward to reach;	Move controls for easy reach;
4. DRILLING OPERATIONS		Loose fittings, flying chips, oil spray, falling parts;	Be sure chuck key is removed and all parts and fittings are secure. Eye and face protection to be worn;
		Clothing/hair caught in drill	Keep hair in place with cap or snood; ties or loose clothing should not be worn - shop coat or apron to fit.
		Spinning parts caught in drill	Back-up bars or hold-down devices to be used to secure material;
		Fumes generated by drilling action on certain types of material or cutting compounds	Make sure there is adequate ventilation and / or devices to remove fumes from worker area
5. FINISHED WORK REMOVAL	See steps 1 and 2.	See steps 1 and 2.	See steps 1 and 2.

See page 5–14d for reproduceable form.

the job procedures in the usual manner and not deliberate or in a self-conscious way. You'll be amazed to discover hazards in what you consider normal job routines, which were previously missed or overlooked. Prepare a separate Job Safety Analysis for each specific job and make it part of the company safety procedure manual. Copies should be provided for use by affected departments or supervisors.

STRUCTURED TRAINING ON-THE-JOB

The Job Analysis helps assure uniform training methods and that all job steps, procedures, and "hazard-alerts" are covered. Also, you can set the pace of instruction and training to the individual worker's ability to learn and progress. Individual copies of the Job Analysis should be made available to each employee for his or her personal reference and use.

POTENTIAL PROBLEM AREAS AND CONDITIONS:

Housekeeping and working conditions

Orderliness in work area
Care and condition of tools
Lifting operations
Pushing materials, carts, etc.
Holding, handling objects
Walking, carrying
Sitting, stretching
Position of body, arms, legs
Running, walking too fast

Potential Hazard Conditions

Falls over objects or falls to same or lower level
Finger, hand, body to be caught in or between objects
Condition to cause abrasion, laceration, or puncture wounds
Sprains or strain
To be struck by or against
Contact with electrical conductor
Contact with or exposure to radioactivity
Contact with or exposure to a caustic or acid
Contact with or exposure to extreme heat, hot objects
Availability of immediate treatment for injuries

Health Hazards

Solvents
Dusts
Fumes
Gases
Noxious odors
Toxic chemicals
Reactive chemicals
Flammable chemicals
Explosive chemicals
Ignition sources

Personal Protection

Gloves, hand creams
Respirators
Eye protection
Face protection
Safety shoes
Head coverings
Ties, kerchiefs
Long sleeves
Long hair
Finger rings

Work Rules

No-smoking areas
Hard hat area
Eye protection areas
Hearing protection areas
Treatment of injuries
Reporting procedures

JOB SAFETY ANALYSIS

page ___ of ___

JOB TITLE / DESCRIPTION	LOCATION / DEPARTMENT	PREPARED BY:	DATE:
		SUPERVISOR	

KEY JOB PROCESS STEPS	TOOLS / MATERIALS USED	POTENTIAL HAZARDS: CONDITIONS OR ACTIONS WHICH COULD CAUSE AN INJURY / AFFECT HEALTH	RECOMMENDED SAFE PRACTICES: PERSONAL PROTECTIVE DEVICES, SPECIAL CLOTHING, PROCEDURES

TRAINING OF EMPLOYEES

The promotion and maintenance of safe practices and safe conditions depends largely upon employees. Theirs is a vital role because they are closest to the actual working conditions and are, therefore, in a position to exercise a great deal of influence over their work environment and fellow employees.

The program outlined below should be regarded as a core around which you may build a thorough training program adapted to your local needs. The basic program consists of five sessions, each one and a half hours in length. These sessions have a logical sequence and are designed to lay the groundwork for more specialized sessions that you may arrange.

The subjects of the basic training sessions are:

Session I – Introduction

Session II – Accident Causes and Control

Session III – Working with People in Accident Prevention

Session IV – Accident Prevention Workshop

Session V – Personal Protective Equipment

The first session should introduce employees to the functions of the safety organization and show them how they fit into the total safety program. An effort should be made to generate enthusiasm and safety consciousness among employees, encouraging them to carry out their jobs effectively without incurring accidents.

The second session is designed to familiarize employees with the causes of accidents and the control measures that should be applied to prevent them.

The third session raises the question of how to handle employees who work unsafely. The point should be made that because people are different, each employee who is seen acting unsafely must be handled as an individual.

During the fourth session, the principles of the third session are applied to actual situations. Each employee is presented with an actual situation that involves an unsafe condition. He is then asked to demonstrate how he would handle the situation. Afterwards, the group should discuss his performance and offer constructive criticism and comments.

The fifth session introduces employees to the reasons for personal protective equipment. The various types of equipment should be shown and explained.

As previously mentioned, these five sessions lay the groundwork for other, more specialized topics with which you may want to deal in additional sessions.

JOB TRAINING

No specific training will stop resentment of authority, distraction, anger, impatience, indifference, or boredom. Therefore control barriers must be established to prevent accidents due to these emotional states. One such control barrier is continuous job training. An employee properly and continually trained will not break the pattern of safe work performance even when in a seriously disturbed or emotional state.

Formal training and retraining courses should be established for all types of jobs. Training and safety meetings should be conducted on topics such as the following:

- New employee indoctrination
- Lifting and material handling methods
- First aid training
- Training in use of fire protection equipment
- Emergency procedures
- Driver training
- Power equipment operation
- Storage limitation of hazardous material
- Lock and tag procedures
- Hazardous materials handling
- Fire safety
- Personal protective equipment

FIRST AID TRAINING

First Aid Training Courses can be arranged with your local Red Cross service representative. Courses are offered at the Red Cross facilities or at your establishment. A minimum of six people are required for in-plant courses. At the time of this writing, Red Cross charged $10 per student, and offered a variety of courses from basic first aid to more advanced training. Included for the $10 fee is a valuable first aid text book.

A free First Aid Training Course may also be arranged through the Mine Safety & Health Administration (MSHA).* Look for the nearest office in the telephone directory, under U.S. Government, Department of Labor, or

*MSHA courses are primarily intended to support mining industry personnel, however, others are accepted if openings exist. The course offered is a "key-man" training program with the expectation that the trained individual will in turn be able to train others in his or her organization.

write to:

U.S. Department of Labor – MSHA
Beckley Training Center
P.O. Box 1166
Beckley, West Virginia 25801
Telephone: (304) 255-0451

FIRE CONTROL PROCEDURES AND TRAINING

Employees must be trained in how to evacuate the building and must know how to call the fire department when a fire occurs. Employees should also be trained to apply the proper control measures when a fire is small. Therefore, employee training in an efficient alarm system and effective fire fighting is essential.

Establish the following training programs:

Fire evacuation plan

Fire department call procedure

Fire Brigade training.

C. Safety Motivation Program

Safety depends upon the desires of employees to work safely. Each employee must be stimulated to think "safety" beyond his usual work environment so that when questionable situations arise he will not commit an unsafe act.

Management must "sell safety" to employees by creating a program that will keep employees interested in safety.

You should establish programs to satisfy the following needs of your employees:

Motivation	Program
Fear	Posters, newsletters about accidents
Pride	Personal awards, trophies, suggestions systems, savings bonds awarded for no accidents
Recognition	Photos and stories in local papers; other publicity
Involvement and Participation	Safety committees and campaigns
Competition	Contests, awards and prizes

WEEKLY SAFETY TALKS – MOTIVATION SESSIONS ADVANCE SCHEDULE OF TOPICS			DEPT. SUPERVISOR
DATE	TOPIC/SUBJECT	SPEAKER	MATERIALS/COMMENTS

WEEKLY SAFETY TALKS – MOTIVATION SESSIONS RECORD

DEPT. _____ MONTH _____

SUPERVISOR _____

DATE	TOPIC COVERED	ATTENDEES	COMMENT

REVIEW COMMENTS _____

D. Medical Program

The objectives of the medical requirements of OSHA (Form 1B) are to ensure: (1) that the employee's physical capabilities make him suitable for his job; (2) that the job does not endanger the employee's health; and (3) that proper medical services are provided in the event of an injury. The program described on the following pages has been developed to help fulfill these objectives.

An accurate system of medical records will facilitate achievement of these goals. Records for each employee should include the date of job placement and a complete history of his or her health maintenance and rehabilitation. A "Guide to Development of an Occupational Medical Record System" is available from The American Medical Association, 535 North Dearborn Street, Chicago, Illinois 60610.

COMPANY PHYSICIAN

The OSHA law makes it necessary for every establishment to have a medical facility and a company doctor or doctors who will agree to handle your medical needs.

Be sure that you have a physician ready and available for advice and consultation on matters of employee health.

Enter your physician's name, address, and telephone number below:

_____
Name of Doctor

_____
Address

_____
Telephone Number

FIRST AID PROCEDURES

The following guideposts are suggested to help you establish First Aid Procedures:

1. The First Aid supplies must be approved by your company doctor.
2. A qualified person must be in charge of the First Aid supplies. The person designated must have First Aid training.

3. The First Aid station must be available to all employees.
4. A notice of emergency numbers should be posted throughout the premises, especially at the First Aid stations. (See *Step 1, Required Notice II.)*
5. A check of First Aid supplies must be made every sixty (60) days by the consulting physician. Kits can be taken to the doctor's office for inspection. Keep a written record of physician's check.

First Aid supplies are located in the following areas:

_____

_____

_____

The person in charge of First Aid supplies is:

_____

HEALTH QUESTIONNAIRE

A health questionnaire, recording the medical history of the applicant, should be completed by every person who applies for a position with your company. This form should also be completed by an employee returning to work after a leave of absence for illness or injury if he has not previously completed the questionnaire.

The applicant should complete this form before reporting to physician for the examination.

The examiner is to review the questionnaire and obtain additional information about any question answered "YES" by the applicant. The examiner's notes concerning these questions are to be written in ink in any available space on the questionnaire and should include such information as:

a. Dates
b. Attending physicians
c. Hospital confinement, if any
d. Other pertinent information

The completed health questionnaire should be sent to management.

PHYSICAL EXAMINATION

In order to achieve the objectives of the Medical Program, as described earlier, the following program of physical examinations should be adopted.

1. A pre-placement physical examination should be required of all applicants for employment. Because people differ in their mental and physical capacities for work, it is most important to determine what type of work each applicant for employment and each employee is mentally and physically capable of doing. The tool that the physician uses in forming his opinion of a person's capacity for work is the physical examination. In judging the suitability of an applicant for employment or an employee for a certain job, the doctor forms an opinion as to whether or not the examinee will be:

   a. A Satisfactory Worker—one who is mentally, physically, and emotionally capable of being a useful employee.

   b. A Safe Worker—one who can work safely if properly placed, instructed, and supervised.

   c. A Good Workers Compensation Risk—one who is free from any disease, injury, or attitude of mind that is likely to substantially increase his or her chances of becoming a Workers Compensation case.

   d. A Good Group Insurance Risk—one who is free from any disease or injury that is very likely to make it necessary for him or her to submit a claim for group insurance in the near future.

An applicant should not be recommended for employment unless he or she measures up to all four standards. Results of the physical examination should be reviewed by management and acted upon before any definite commitment concerning employment is made between the company and the applicant.

2. A periodic physical examination of every employee will reveal any disease or illness at an early state, and help to determine whether or not the employee's health status is compatible with his assignment. Annual re-examination should be required of all the following employees:

   Vehicle Operators

   Crane Operators

   Persons exposed to toxic substances (lead, paint, sand, *etc.*)

3. Re-examination should be required of an employee returning to work after an absence caused by:

   Sickness of long duration

   Major surgery

   Re-employment after leaving for any reason

   Re-examination should also be required prior to re-assignment of an employee to duties requiring particular medical fitness, or whenever a question arises as to the continuing physical fitness of an individual for his work. The purpose of the physical examination should be to determine whether or not the individual concerned is medically fit to perform, without risk to his own health or that of others, the work to which he is or will be assigned.

The following procedure is suggested for the pre-placement physical examination.

The Health Questionnaire should be completed by the applicant prior to reporting for the physical examination. During this interview, the physician should obtain further information about questions to which a "Yes" answer has been given, and should write this information in the margin.

The Physical Examination Form should be filled in by the physician on the basis of the examination findings. As indicated on the form, only positive findings need to be noted. However, items 1 though 5 must be filled in, and the appropriate squares in Items 51 and 52 are to be checked in all cases. The physician should note the Classification and any Limitations in the spaces provided.

The preparation of standards for pre-placement examinations presents difficulties, one of which is the impracticability of covering every conceivable deviation from normal. The instructions are intended as a general guide, and cannot be applied arbitrarily to all instances. In the final analysis the classification of an applicant for employment requires the clinical judgment of the examining physician.

For a return-to-work examination, the physician should complete the appropriate section of the form and write a short note concerning the illness, injury, or pregnancy that caused the absence.

The examination should include a complete medical history, clinical examination, hemoglobin test, urinalysis, vision test, hearing test, and a Mantoux test, as well as those described below.

Lumbar Spine X-Rays: Antero-posterior and lateral views are required for all applicants seeking employment. This is a must.

Chest X-Rays: Chest plates are required for all applicants seeking employment.

Fasting Blood Sugar Test—Post Prandial Sugar Test: These tests are required whenever the urine shows sugar, whenever there is a family history of diabetes, or whenever the applicant has diabetes.

Other tests: If the examining physician feels additional tests are indicated, his recommendations should be noted on the Physical Examination Form. Management will then review the recommendations and determine whether the additional tests should be performed.

The examining physician does not decide whether the applicant shall be employed. The physician merely determines whether or not the applicant measures up to the medical standards set forth in this manual for the specific work for which the applicant is being considered. The physician should note the applicant's classification and any limitations on the Physical Examination Form in the space provided and on the Physical Examination Record.

The examining physician is to return the Physical Examination form and the Health Questionnaire to the company's management.

It is the obligation of the examining physician to discuss any abnormalities of consequence with the applicant. When further advice and treatment seem indicated, the applicant should be urged to consult a personal physician and inform that the results of this examination are available upon request and with the consent of the applicant.

A separate file folder should be kept for each employee. All medical data pertaining to the individual should be placed in this folder. Because of the confidential nature of this information, only authorized personnel should have access to the medical files. The file cabinets must be kept locked.

SAMPLE

HEALTH QUESTIONNAIRE (Fill in Completely)

NAME SS No. DATE

ADDRESS (STREET) (CITY & STATE) PHONE NO.

BIRTH DATE	YOUR JOB	HEIGHT	WEIGHT	SINGLE MARRIED DIVORCED	SEPARATED WIDOW WIDOWER	DEPENDENTS

AGE ON LEAVING SCHOOL	CIRCLE LAST GRADE COMPLETED	STUDENT NOW?	POSITION APPLIED FOR
	GRADE SCHOOL 5 6 7 8 HIGH SCHOOL 1 2 3 4 COLLEGE 1 2 3 4 5 6 7 8	YES NO	SUPERVISOR DEPARTMENT HEAD LOCATION

FORMER EMPLOYER:

YOUR DOCTOR'S NAME

HIS ADDRESS

FAMILY RECORD

	LIVING		DEAD		
	AGE	HEALTH	AGE	DATE OF DEATH	CAUSE OF DEATH
FATHER					
MOTHER					
BROTHERS					
SISTERS					

TO THE APPLICANT: PLEASE COMPLETE THIS FORM BEFORE YOU ARE EXAMINED BY THE DOCTOR.

This examination is for the purpose of assisting the employment department in placing you in a job safe to yourself and others according to your physical ability. A physical impairment does not necessarily disqualify you. Your cooperation in answering the following questions is requested:

DIRECTIONS:
If you can answer YES to the question put a circle around the YES AND ADD DETAILS
If you answer NO to the question put a circle around the NO.

1. Do you need glasses to read? . . . . . Yes No
2. Do you need glasses to see things at a distance? . . . . . Yes No
3. Do you often have bad pains in your eyes? . . . Yes No
4. Are your eyes often red or inflamed? . . . . . Yes No
5. Are you hard of hearing? . . . . . Yes No
6. Have you ever had a bad running ear? . . . . Yes No
7. Do you have constant noises in your ears? . . . Yes No
8. Do you often catch severe colds? . . . . . Yes No
9. Do you frequently suffer from heavy chest colds? . Yes No
10. Have you ever had T.B. (Tuberculosis)? . . . . Yes No
11. Did you ever live with anyone who had T.B.? . . Yes No
12. Do you get hay fever? . . . . . Yes No
13. Do you suffer from asthma? . . . . . Yes No
14. Are you allergic to any foods, dust, animals, vegetation? . . . . . Yes No
15. Have you ever had sinus trouble? . . . . . Yes No
16. Are you troubled by constant coughing? . . . . Yes No
17. Have you ever coughed up blood? . . . . . Yes No
18. Do you sometimes have severe soaking sweats at night? . . . . . Yes No
19. Has a doctor ever said your blood pressure was too high? . . . . . Yes No
20. Do you have pains in the heart or chest? . . . . Yes No
21. Are you often bothered by thumping of the heart? . . . . . Yes No
22. Are your ankles often badly swollen? . . . . . Yes No
23. Has a doctor ever said you had heart trouble? . . Yes No
24. Do you often suffer from an upset stomach? . . Yes No
25. Do you usually feel bloated after eating? . . . Yes No
26. Do you suffer from indigestion? . . . . . Yes No
27. Do you suffer from frequent loose bowel movements? . . . . . Yes No
28. Do you constantly suffer from bad constipation? . . . . . Yes No
29. Have you ever had colitis? . . . . . Yes No
30. Have you ever had piles? (rectal hemorrhoids) . . Yes No
31. Have you have had jaundice? . . . . . Yes No
32. Have you ever had serious liver or gall bladder trouble? . . . . . Yes No
33. Are your joints often painfully swollen? . . . . Yes No
34. Do weak or painful feet make your life miserable? . . . . . Yes No
35. Do pains in the back make it hard for you to keep up with your work? . . . . . Yes No
36. Have you ever had a backache? . . . . . Yes No
37. Have you ever had pains in your leg or so-called sciatica? . . . . . Yes No
38. Have you ever had an injury to your back? . . . Yes No
39. Have you ever seen a medical doctor, osteopath or chiropractor regarding your back? . . . . . Yes No
40. Is your skin more sensitive than average? . . . Yes No
41. Have you had any skin disease? . . . . . Yes No
42. Do you suffer badly from frequent severe headaches? . . . . . Yes No
43. Have you fainted more than twice in your life? . Yes No
44. Was any part of your body ever paralyzed? . . . Yes No
45. Were you ever knocked unconscious? . . . . . Yes No
46. Have you ever had epilepsy? . . . . . Yes No
47. Has a doctor ever said you had a hernia? . . . . Yes No

SAMPLE

Give details on all questions answered "Yes"

48. Do you have to urinate frequently? . . . . . Yes No
49. Do you ever have painful urination? . . . . . Yes No
50. Has a doctor ever said you had kidney or bladder disease? . . . . . Yes No
51. Are you frequently ill? . . . . . Yes No
52. As a child did you have rheumatic fever, growing pains or twitching of the limbs? . . . . Yes No
53. Did you ever have malaria? . . . . . Yes No
54. Were you ever treated for severe anemia? . . . Yes No
55. Did a doctor ever say you had a goiter? . . . . Yes No
56. Did a doctor ever treat you for tumor or cancer? . . . . . Yes No
57. Do you suffer from any chronic disease? . . . . Yes No
58. Did a doctor ever say you had varicose veins (swollen veins)? . . . . . Yes No
59. Did you ever have a serious operation? . . . . Yes No
60. Did you ever have a serious injury? . . . . . Yes No
61. Have you any scars on your face or body? . . . Yes No
62. Have you ever injured your knees? . . . . . Yes No
63. Have you ever fractured or broken a bone? . . . Yes No
64. Have you ever worked in a mine, foundry, brick yard, pottery, quarry, or as a sand blaster or stone cutter? . . . . . Yes No
65. Do you smoke more than 20 cigarettes a day? . . Yes No
66. Do strange people or places make you afraid? . . . . . Yes No
67. Do you usually feel unhappy and depressed? . . Yes No
68. Is it always hard for you to make up your mind? . . . . . Yes No
69. Do you often get a spell of complete exhaustion or fatigue? . . . . . Yes No
70. Do you usually have great difficulty in falling asleep or staying asleep? . . . . . Yes No
71. Do you often wish you were dead and away from it all? . . . . . Yes No
72. Do you get nervous and shaky when approached by a superior? . . . . . Yes No
73. Are your feelings easily hurt? . . . . . Yes No
74. Does every little thing get on your nerves and wear you out? . . . . . Yes No
75. Are you considered a nervous person? . . . . Yes No
76. Did you ever have a nervous breakdown? . . . Yes No
77. Are you extremely shy or sensitive? . . . . . Yes No
78. Were you ever a patient in a mental hospital? . . Yes No
79. Does criticism upset you? . . . . . Yes No
80. Are you easily upset or irritated? . . . . . Yes No
81. Does it make you angry to have anyone tell you what to do? . . . . . Yes No
82. Do people often annoy and irritate you? . . . . Yes No
83. Are you constantly keyed up and jittery? . . . Yes No
84. Do sudden noises make you jump or shake badly? . . . . . Yes No
85. Have you ever been rejected for service in the Armed Forces? . . . . . Yes No
86. Have you ever been rejected for life insurance? . . . . . Yes No
87. Have you had any medical treatment during the past three years? If yes, give details. . . . . Yes No
88. Have you ever received any percentage disability payments from the U.S. Government? If so, give details. . . . . Yes No
89. Have you ever received any other disability payments? If so, give details. . . . . Yes No
90. Have you or any member of your family ever had diabetes? . . . . . Yes No
91. Have you ever worked for this company before? . Yes No
92. Have you ever been rejected for employment by this company? If so, give reason. . . . . Yes No
93. Have you ever had syphillis or any other veneral disease? . . . . . Yes No
94. Have you had any illness or disease not included in the above questions? . . . . . Yes No
95. What is your selective service classification?
96. Have you ever had brucellosis? . . . . . Yes No
97. Do you have bad vision in both eyes? . . . . . Yes No
98. Have you ever had stomach ulcers? . . . . . Yes No

I hereby certify that all statements and answers provided by me in this questionnaire are complete and true to the best of my knowledge, and I agree that they are to be considered part of basis for employment. I further agree that any falsification of this record including failure to answer any question will be considered grounds for discharge. I hereby authorize any physician or any other person who has attended me to make a full disclosure of any information in his knowledge concerning my medical history. Further, I expressly waive any rights which preclude the disclosure of such information.

Signature _____ Date _____

NAME _____ DATE _____

ADDRESS _____ PHONE _____
(STREET) (CITY) (STATE)

1. AGE 2. SEX 3. TEMP. 4. PULSE 5. WEIGHT HEIGHT

6. HGB.

7. URINALYSIS

8. BLOOD PRESSURE
IF ELEVATED, TAKE 3 MORE READINGS AFTER REST PERIODS, AND RECORD RESULTS BELOW.

NO. 9 THROUGH 50: MARK WITH CROSS (X) IF FINDINGS ARE ABNORMAL, AND WRITE REMARKS CONCERNING ABNORMAL FINDINGS IN SPACE BELOW.

9. MOUTH	
10. TONGUE	
11. GUMS	
12. SALIVARY GLANDS	
13. PHARYNX	
14. TONSILS	
15. EYES	
16. PUPILS	
17. EYE GROUNDS	
18. FIELDS	
19. NOSE	
20. SINUSES	
21. EARS	
22. MASTOIDS	
23. NECK	
24. THYROID	
25. LYMPH GLANDS	
26. CHEST	
27. BREASTS	
28. HEART	
29. LUNGS	
30. ABDOMEN	
31. LIVER	
32. SPLEEN	
33. KIDNEYS	
34. GALL BLADDER	
35. TENDON REFLEXES	
36. VIBRATION SENSE	
37. SENSATION	
38. KERNIG	
39. ROMBERG	
40. PERIPHERAL VESSELS	
41. EDEMA	
42. RECTAL	
43. BACK	
44. HANDS AND ARMS	
45. FEET AND LEGS	
46. VARICOSITIES	
47. SPINE	
48. MALE GENITALIA	
49. HERNIA	
50. SKIN	
51. TEETH	

FOR FEMALE APPLICANTS ONLY

DATE L.M.P.	
REGULAR	
DYSMENORRHEA	
MENORRHAGIA	
METRORRHAGIA	
PREGNANCIES	
52. VISION	

CLASSIFICATION 1 2 3 4

LIMITATIONS:

Satisfactory

Plate
Upper Partial - Lower Partial

Plate
Lower Partial - Upper Partial

Needs Dental Care

Satisfactory

Needs Reading Glasses

Must Wear Corrected

Safety Glasses

Vision
Without Glasses L ___ R ___

Vision
With Glasses L ___ R ___

Signature of Physician Date

Address

HEARING IS PRICELESS . . . PROTECT IT!

I hereby acknowledge that:
(Check below)

____ 1. I have had an audiogram made of my hearing capabilities.

____ 2. I have been fitted for and have received free from the Company, one pair of ear plugs: Size_____ Type_____.

____ 3. I agree to wear these ear plugs according to the rules established by the Company.

____ 4. I may exchange my pair of ear plugs if damaged through normal wear by contacting the Plant Nurse.

____ 5. I understand that any replacement of ear plugs through loss or misplacement will be at my own expense.

____ 6. I have been instructed in the method of inserting, using and caring for these ear protectors.

____ 7. I have received a booklet describing why this hearing protection is necessary.

The following (areas, departments and/or machines) require the use of ear protection devices:

_____

_____

Employee's Signature_____

Company_____ By_____

Date_____

NAME	DATE OF BIRTH	DATE OF HIRE	SOCIAL SECURITY NO.	CLOCK NO

OCCUPATIONAL HISTORY (Beginning with the last previous employer and working back to first.)

EMPLOYER	CITY	DUTIES	LENGTH OF SERVICE	NOISE EXPOSURE	EAR PROTECTORS
1.				☐ YES ☐ NO	☐ YES ☐ NO
2.				☐ YES ☐ NO	☐ YES ☐ NO
3.				☐ YES ☐ NO	☐ YES ☐ NO
4.				☐ YES ☐ NO	☐ YES ☐ NO

MILITARY SERVICE: DATES ASSIGNMENT

EAR HEALTH HISTORY

HAVE YOU EVER HAD:

Ear trouble? ☐ YES ☐ NO If "YES", explain _____

Difficulty in hearing? ☐ YES ☐ NO Ear infection or running ear? ☐ YES ☐ NO

Surgery in either ear? ☐ YES ☐ NO If "YES", explain _____

Noises in your ears? ☐ YES ☐ NO What does it sound like? _____

Measles? . . . . . ☐ YES ☐ NO Mumps? . . . . . ☐ YES ☐ NO Scarlet Fever ☐ YES ☐ NO

HAVE YOU EVER BEEN:

Knocked unconscious? ☐ YES ☐ NO

To a doctor for ear trouble or problems? ☐ YES ☐ NO If "YES", explain _____

Exposed to any gun fire or other loud noises? ☐ YES ☐ NO

What antibiotics have you taken? _____

Do you have any noisy hobbies? ☐ YES ☐ NO Do you have a second job? ☐ YES ☐ NO

Have you had a hearing measurement before? ☐ YES ☐ NO If "YES", where? _____

Does anyone in your family have a hearing loss? ☐ YES ☐ NO

AUDIOGRAM NO	TIME SINCE LAST NOISE EXPOSURE	TYPE OF EXPOSURE	JOB LOCATION	COMMENTS ON EAR HEALTH HISTORY UPDATING

PERIODIC PURE TONE AUDIOMETRIC EXAMINATION RECORD

DATE AND TIME	Reference Standard*	RIGHT EAR									LEFT EAR									AUDIOMETER SERIAL NUMBER	COMMENT	TECHNICIAN
		250	500	1000	1500	2000	3000	4000	6000	8000	250	500	1000	1500	2000	3000	4000	6000	8000			

*Standard Reference Codes: A = A.S.A.
B = I.S.O.
C = ANSI

(Insert proper reference code in second column for each audiogram.)

HEARING MEASUREMENT SUMMARY SHEET

COMPLETED AUDIOGRAMS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTALS
Prospective Employees													
Rehires													
Rechecks													
Totals													

Referrals													

Station _____

Report by _____

Date _____

Company
or Clinic____

AUDIOMETER: Make____________ S.N.____________ Technician____________

__________ CLINIC CALIBRATION RECORD

DATE	HOW	BY	LT		500	1000	2000	3000	4000	6000		RT	500	1000	2000	3000	4000	6000			COMMENTS

__________ must be notified when corrections are necessary.

HAZARD COMMUNICATION AND RIGHT-TO-KNOW

There is a growing concern over the many types of chemicals and potentially hazardous substances found in the working environment. The proliferation of state and local "Right to Know" laws and OSHA's Hazard Communication Standard attest to the concern being expressed at government levels.

Hazardous materials in the workplace must be properly marked, and data sheets should be available to help educate employees. Employees should be informed about the nature of the chemical hazards to which they may be exposed, and be trained in safe handling procedures for those substances. Many of these requirements are mandatory under OSHA's Hazard Communication Standard (see page Z-101 in Vol. 1).

The following information on identification systems, labeling, placarding, and material safety data sheets, is designed to help you set up a hazard communication program in your workplace, complete with labeling and material safety data sheet specifications and sample forms.

The material presented here is based on earlier NIOSH recommendations which were derived from the requirements of various agencies, including: The Food and Drug Administration, Consumer Products Safety Commission, Environmental Protection Agency, United Nations, U.S. Department of Transportation, National Fire Protection Association and the Manufacturing Chemists Association.

In addition, we are including a two-page format material safety data sheet (OSHA Form 20) which is used in OSHA's Shipyard standards and can be used to supply the necessary information to employees. This is on page 5-26s.

ASSIGNMENT OF HAZARD RATING

All materials determined to be hazardous must be assigned a relative hazard rating in three categories: **health, fire,** and **reactivity**. Material safety data sheets, labels, and placards should provide ratings for any or all three of the following criteria: toxicity, flammability or combustibility, and reactivity.

A. **Toxicity** — A toxic substance is one that has demonstrated the potential to endanger human life by exposure via any route found in the workplace; produce short- or long-term disease or bodily injury, affect health adversely; . . . induce transmissible change in characteristics or cause production of physical defects in an offspring or developing human or experimental animal embryo. In the absence of human or animal effects data, a toxic substance is one that produces death in experimental animals exposed to the substance in quantities and by routes which are reasonable. (See rating guide on page 5-26h.)

B. **Flammability or Combustibility** — Determination of degree of fire hazard rating is to be made based upon the potential for harm and the relative flammability of the material or mixture of materials. Test procedures as found in 20 CFR 1910.106 and 107 are mandatory for liquids. The relative ratings are taken from the NFPA 704M booklet, with changes in flash point to reflect OSHA regulations. (See rating guide on page 5-26i.)

C. **Degree of Reactivity** — Materials in this category may be self-reactive by polymerization, decomposition, or condensation, and/or reactive with other materials commonly encountered in the workplace. Comments relate to need for safe storage and handling of hazardous, unstable substances. (See rating guide on page 5-26j.)

A
RELATIVE HEALTH HAZARD RATING GUIDES FOR TOXIC MATERIALS

RATING	KEY WORDS	HUMAN EXPOSURE OR CONTACT TO TOXIC MATERIALS		TEST ANIMAL EXPOSURE OR CONTACT		
				RELATIVE ACUTE TOXICITY CRITERIA[3]		
		ACUTE EXPOSURE (Single exposure causing immediate or delayed effects)	CHRONIC EXPOSURE (Repeated exposure)	LD50 Single Oral Dose: Rats mg/kg	LC50 Inhalation Vapor Exposure: Rats ppm	LD50 Skin: Rabbits mg/kg
		POSSIBLE EFFECT OR RESULT:		LESS THAN OR EQUAL TO:		
4	EXTREME HEALTH HAZARD	Death	Death [1]	1	10	5
3	HIGH HEALTH HAZARD	Major temporary or permanent injury. May threaten life.	Major permanent injury. (Includes mutagens and teratogens.)	50	100	43
2	MODERATE HEALTH HAZARD	Minor temporary or permanent injury. [2] (Includes nonlife threatening substances which sensitize the majority of exposed workers.)	Minor temporary or permanent injury. (Includes skin carcinogens.)	500	1,000	340
1	SLIGHT HEALTH HAZARD	Minor injury. Readily reversible. [2]	Minor injury. Readily reversible.	5,000	10,000	2,800
0	NO SIGNIFICANT HEALTH HAZARD	Materials which produce toxic effects only under the most unusual conditions or by overwhelming dosage.		5,000 or greater	10,000 or greater	2,800 or greater

[1] Includes substances which bear a significant relationship to the development of cancer in man, but excluding the common varieties of skin cancer.

[2] Allergens are rated according to their sensitizing potential rather than the severity of an allergic reaction upon reexposure to a substance by a sensitized worker.

[3] In the interest of standardization, NIOSH recommends the animal testing procedures of the National Academy of Sciences, or of The Food and Drug Administration as published by The Association of Food and Drug officials of the U.S.

CONDENSED GLOSSARY OF TERMS

ACUTE	A short time period of action measured in seconds, minutes, hours, or days.
ACUTE EFFECT	Applies to injuries which rapidly follow exposure to hazardous material without implying degree of severity.
CHRONIC	Applies to long time period of action in weeks, months, or years.
CHRONIC EFFECT	Applies to injuries which are delayed after exposure to a hazardous material.
LC50	The air concentration which is required to produce death in 50% of the exposed animals.
LD50	The dose which is required to produce death in 50% of the exposed animals.
SENSITIZER	A substance which can cause an allergic-like response.

B
FLAMMABILITY OR COMBUSTIBILITY RATING

RATING	KEY WORDING OR TERM	PROPERTIES OR CONDITIONS OF MATERIAL
4	EXTREMELY FLAMMABLE	Any liquid or gaseous material which is a liquid under pressure having flash point below 73° F (22.8° C). Also materials which can form explosive mixtures with air and which are readily dispersed in air, such as dusts of combustible solids, and mists of flammable or combustible liquid droplets.
3	HIGHLY FLAMMABLE	Liquids and solids that can be ignited under almost all ambient temperature conditions. Liquids having a flash point at or above 73° F (22.8° C) but below 100° F (37.8° C).
2	MODERATELY COMBUSTIBLE	Materials that must be moderately heated or exposed to high ambient temperatures before ignition can occur. Rating would apply to liquids having a flash point above 100° F (37.8° C) but below 200° F (93.4° C).
1	SLIGHTLY COMBUSTIBLE	Materials that must be preheated before ignition can occur. Rating includes materials which will burn in air when exposed to a temperature of 1,500° F (815° C) for a period of 5 minutes or less. Liquids, solids and semisolids having a flash point at or above 200° F (93.4° C).
0	NONCOMBUSTIBLE	Any material which will not burn in air when exposed to a temperature of 1,500° F (815° C) for a period of 5 minutes.

C
REACTIVITY RATING

RATING	KEY WORDING OR TERM	PROPERTIES OR CONDITIONS OF MATERIAL
4	EXTREMELY REACTIVE	Materials readily capable of detonation, explosive decomposition, or explosive reaction at normal temperatures and pressures. Includes material sensitive to mechanical or localized thermal shock.
3	HIGHLY REACTIVE	Materials capable of detonation or of explosive decomposition or explosive reaction if subjected to a strong initiating source, or which must be heated under confinement before initiation. Also includes materials sensitive to thermal or mechanical shock at elevated temperatures and pressures. Materials which react explosively with water without requiring heat or confinement.
2	MODERATELY REACTIVE	Materials which in themselves are normally unstable and readily undergo rapid chemical changes but do not detonate. They may cause a rapid release of energy at normal temperatures and pressures. Also may react violently with water.
1	SLIGHTLY REACTIVE	Normally stable materials which can become unstable at elevated temperatures and pressures. Also may react violently with water with some release of energy.
0	NONREACTIVE	Materials that remain stable even under fire exposure and do not react with water.

4	Extreme Health Hazard
4	Extremely Flammable
2	Moderately Reactive

Fatal if swallowed, inhaled, or absorbed through the skin.

Causes severe eye burns.

Protect from all sources of ignition.

Subject to violent polymerization.

Do not breathe vapor or get in eyes, on skin, on clothing.

When possibility of contact exists:
Wear full neoprene suit, rubber boots, rubber gloves, and self-contained breathing apparatus.

Avoid contact with acid, organic compounds, or water.

FIRST AID CALL A PHYSICAN AS SOON AS POSSIBLE

Immediately upon exposure flush skin and eyes with water for 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Discard contaminated shoes.

Refer to Data Sheet on file.

Example of Label Information

LABELING HAZARDOUS AND TOXIC MATERIALS

Correct and complete label information is most important. The label statements are intermediate in information content between the hazard symbol and the detailed material safety data sheets. Label wording should be tailored specifically for each material, or combination of materials. The label should include the trade name of the product, or be positioned near the trade name. It should show the hazard alert symbol, statements on the nature of the hazard, appropriate action statements, and first-aid statements where useful. If overexposure requires unusual treatment or specific counteractive drugs, this must be noted. Where applicable, specific clean-up and disposal statements should be included. Also include a reference to the appropriate MSDS so that additional data, if needed, can quickly be located. If prepared in color, refer to CFR 1910.144 for color coding guides. Suggested colors for the numerical rating, degree of hazard, and key words are:

Health (Toxicity)	Blue numerals or letters on white background or black numerals or letters on blue background
Fire (Flammability)	Red on white or black on red
Reactivity	Yellow on white or black on yellow

4	Extreme Health Hazard
3	Highly Flammable
2	Moderately Reactive

Fatal if swallowed, inhaled, or absorbed through the skin.

Causes severe eye burns.

Protect from all sources of ignition.

Subject to violent polymerization.

Example of Placard Information

THE PLACARD

A placard may be simple or detailed and of a size dependent on its intended area of effectiveness. It may contain a hazard symbol only, a hazard symbol and label statements, or only label statements. You may want to use placards in any of these major ways: (1) on exterior tanks, buildings, and fenced-in areas; (2) on signboards or affixed to interior areas to warn of hazardous areas; or (3) on doors or machinery to warn workers of immediate hazards. In this use you may want to include more detailed warnings and action statements because of the proximity of the hazard and the regular use of the hazardous material.

Please Note: The material presented here is a *condensed version* of the recommended standard produced by the U.S. Department of Health and Human Services, contained in NTIS Publication No. PB-246-698/A04, An Identification System for Occupationally Hazardous Materials. For the complete text, order from the National Technical Information Service, U.S. Dept. of Commerce, Springfield, VA 22161.

MATERIAL SAFETY DATA SHEETS

A key ingredient in any hazard communication program is the material safety data sheet (MSDS). These sheets contain detailed information on the hazards of each hazardous material in the workplace.

Although there is no single, approved format for MSDSs, certain information must always be included: the specific chemical identity of the hazardous chemical(s) and the common name(s), the physical and chemical characteristics of the substance, known acute and chronic health effects and related health information, exposure limits, whether the chemical is considered a carcinogen, precautionary measures to be taken, emergency and first aid procedures, the identification of the person and organization responsible for preparing the MSDS, and the date of preparation. Under OSHA's hazard communication standard, blank spaces are not permitted. Inapplicable or unavailable information must be so indicated.

Employers are responsible for making sure that there is a MSDS for every hazardous chemical used in the workplace. They also must ensure that MSDSs are readily accessible to employees, that employees know where in the workplace the MSDSs are located, and know how to read, understand, and make use of the information contained on the data sheets.

It might be helpful to use the instruction sheet appearing on the next page to help inform employees about the purposes and uses of MSDSs.

The following pages provides samples of material safety data sheet forms from NIOSH and OSHA. The form on page 5-26 s,t is that required by OSHA in its maritime (shipyard) standards. The form on page 5-26 u,v is a nonmandatory form which can be used to comply with the hazard communication standard (1910.1200). This is an updated version of the maritime MSDS, and is designed for use by general industry. All of these forms may be freely reproduced.

MATERIAL SAFETY DATA SHEETS

EMPLOYEE INFORMATION

Material safety data sheets provide important information about the hazardous materials found in the workplace. Some of the information on the data sheets is general — the chemical's name, ingredients, manufacurer's name, etc. Other information is more technical.

Material safety data sheets can tell you if a material is flammable or explosive, if it is poisonous or cancer causing, how much of it you can safely be exposed to, and if you need special protective equipment while working with the substance.

You can find out what materials should not come into contact with the substance and how to properly handle and store the material. MSDSs outline spill clean-up procedures, and what to do if the material is involved in a fire.

Also, MSDSs provide information so you can tell when you or your fellow workers have been overexposed, and what the medical and first aid procedures are in case of overexposure.

Be sure to become familiar with the hazardous substances you work with by studying the applicable material safety data sheets. Workplace MSDSs are located

_____ . See _____ with
(give location) (authorized person)
any questions you might have about material safety data sheets.

MATERIAL NAME:

RATING NO.	(KEY WORD — RE: HEALTH HAZARD — TOXICITY)
	(KEY WORD — RE: COMBUSTIBILITY — FLAMMABILITY)
	(KEY WORD — RE: REACTIVITY)

MATERIAL SAFETY DATA SHEET

I PRODUCT IDENTIFICATION

MANUFACTURER'S NAME	REGULAR TELEPHONE NO. EMERGENCY TELEPHONE NO.
ADDRESS	
TRADE NAME	
SYNONYMS	

II HAZARDOUS INGREDIENTS

MATERIAL OR COMPONENT	%	HAZARD DATA

III PHYSICAL DATA

BOILING POINT, 760 MM HG		MELTING POINT
SPECIFIC GRAVITY (H_2O-1)		VAPOR PRESSURE
VAPOR DENSITY (AIR=1)		SOLUBILITY IN H_2O, %, BY WT
% VOLATILES BY VOL		EVAPORATION RATE (BUTYL ACETATE 1)
APPEARANCE AND ODOR		

NIOSH — Recommended MSDS Format — First Page

IV FIRE AND EXPLOSION DATA

FLASH POINT (TEST METHOD)		AUTOIGNITION TEMPERATURE	

FLAMMABLE LIMITS IN AIR, % BY VOL.	LOWER		UPPER	

EXTINGUISHING MEDIA	
SPECIAL FIRE FIGHTING PROCEDURES	
UNUSUAL FIRE AND EXPLOSION HAZARD	

V HEALTH HAZARD INFORMATION

HEALTH HAZARD DATA

ROUTES OF EXPOSURE

- INHALATION
- SKIN CONTACT
- SKIN ABSORPTION
- EYE CONTACT
- INGESTION

EFFECTS OF OVEREXPOSURE

- ACUTE OVEREXPOSURE
- CHRONIC OVEREXPOSURE

EMERGENCY AND FIRST AID PROCEDURES

- EYES
- SKIN
- INHALATION
- INGESTION

NOTES TO PHYSICIAN

NIOSH — Recommended MSDS Format — Second Page

VI REACTIVITY DATA

CONDITIONS CONTRIBUTING TO INSTABILITY

INCOMPATIBILITY

HAZARDOUS DECOMPOSITION PRODUCTS

CONDITIONS CONTRIBUTING TO HAZARDOUS POLYMERIZATION

VII SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED

NEUTRALIZING CHEMICALS

WASTE DISPOSAL METHOD

VIII SPECIAL PROTECTION INFORMATION

VENTILATION REQUIREMENTS

SPECIFIC PERSONAL PROTECTIVE EQUIPMENT

RESPIRATORY (SPECIFY IN DETAIL)

EYE

GLOVES

OTHER CLOTHING AND EQUIPMENT

NIOSH — Recommended MSDS Format — Third Page

IX SPECIAL PRECAUTIONS

PRECAUTIONARY STATEMENTS

OTHER HANDLING AND STORAGE REQUIREMENTS

PREPARED BY

ADDRESS

DATE

NIOSH — Recommended MSDS Format — Fourth Page

U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration

Form Approved
OMB No. 44-R1387

MATERIAL SAFETY DATA SHEET

Required under USDL Safety and Health Regulations for Ship Repairing, Shipbuilding, and Shipbreaking (29 CFR 1915, 1916, 1917)

SECTION I

MANUFACTURER'S NAME	EMERGENCY TELEPHONE NO.
ADDRESS *(Number, Street, City, State, and ZIP Code)*	
CHEMICAL NAME AND SYNONYMS	TRADE NAME AND SYNONYMS
CHEMICAL FAMILY	FORMULA

SECTION II - HAZARDOUS INGREDIENTS

PAINTS, PRESERVATIVES, & SOLVENTS	%	TLV (Units)	ALLOYS AND METALLIC COATINGS	%	TLV (Units)
PIGMENTS			BASE METAL		
CATALYST			ALLOYS		
VEHICLE			METALLIC COATINGS		
SOLVENTS			FILLER METAL PLUS COATING OR CORE FLUX		
ADDITIVES			OTHERS		
OTHERS					

HAZARDOUS MIXTURES OF OTHER LIQUIDS, SOLIDS, OR GASES	%	TLV (Units)

SECTION III - PHYSICAL DATA

BOILING POINT (°F.)		SPECIFIC GRAVITY (H_2O=1)	
VAPOR PRESSURE (mm Hg.)		PERCENT, VOLATILE BY VOLUME (%)	
VAPOR DENSITY (AIR=1)		EVAPORATION RATE (_____ =1)	
SOLUBILITY IN WATER			
APPEARANCE AND ODOR			

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (Method used)	FLAMMABLE LIMITS	Lel	Uel
EXTINGUISHING MEDIA			
SPECIAL FIRE FIGHTING PROCEDURES			
UNUSUAL FIRE AND EXPLOSION HAZARDS			

SECTION V - HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE

EFFECTS OF OVEREXPOSURE

EMERGENCY AND FIRST AID PROCEDURES

SECTION VI - REACTIVITY DATA

STABILITY	UNSTABLE		CONDITIONS TO AVOID
	STABLE		

INCOMPATABILITY *(Materials to avoid)*

HAZARDOUS DECOMPOSITION PRODUCTS

HAZARDOUS POLYMERIZATION	MAY OCCUR		CONDITIONS TO AVOID
	WILL NOT OCCUR		

SECTION VII - SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED

WASTE DISPOSAL METHOD

SECTION VIII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION *(Specify type)*

VENTILATION	LOCAL EXHAUST	SPECIAL
	MECHANICAL *(General)*	OTHER

PROTECTIVE GLOVES	EYE PROTECTION

OTHER PROTECTIVE EQUIPMENT

SECTION IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING

OTHER PRECAUTIONS

Material Safety Data Sheet

May be used to comply with OSHA's Hazard Communication Standard, 29 CFR 1910.1200. Standard must be consulted for specific requirements.

U.S. Department of Labor
Occupational Safety and Health Administration
(Non-Mandatory Form)
Form Approved
OMB No. 1218-0072

IDENTITY *(As Used on Label and List)*

Note: Blank spaces are not permitted. If any item is not applicable, or no information is available, the space must be marked to indicate that.

Section I

Manufacturer's Name	Emergency Telephone Number
Address *(Number, Street, City, State, and ZIP Code)*	Telephone Number for Information
	Date Prepared
	Signature of Preparer *(optional)*

Section II — Hazardous Ingredients/Identity Information

Hazardous Components (Specific Chemical Identity; Common Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% *(optional)*

Section III — Physical/Chemical Characteristics

Boiling Point		Specific Gravity (H_2O = 1)	
Vapor Pressure (mm Hg.)		Melting Point	
Vapor Density (AIR = 1)		Evaporation Rate (Butyl Acetate = 1)	

Solubility in Water

Appearance and Odor

Section IV — Fire and Explosion Hazard Data

Flash Point (Method Used)	Flammable Limits	LEL	UEL

Extinguishing Media

Special Fire Fighting Procedures

Unusual Fire and Explosion Hazards

Section V — Reactivity Data

Stability	Unstable		Conditions to Avoid
	Stable		

Incompatibility (*Materials to Avoid*)

Hazardous Decomposition or Byproducts

Hazardous Polymerization	May Occur		Conditions to Avoid
	Will Not Occur		

Section VI — Health Hazard Data

Route(s) of Entry: Inhalation? Skin? Ingestion

Health Hazards (*Acute and Chronic*)

Carcinogenicity: NTP? IARC Monographs? OSHA Regulated?

Signs and Symptoms of Exposure

Medical Conditions
Generally Aggravated by Exposure

Emergency and First Aid Procedures

Section VII — Precautions for Safe Handling and Use

Steps to Be Taken in Case Material Is Released or Spilled

Waste Disposal Method

Precautions to Be Taken in Handling and Storing

Other Precautions

Section VIII — Control Measures

Respiratory Protection (*Specify Type*)

Ventilation	Local Exhaust	Special
	Mechanical (*General*)	Other

Protective Gloves	Eye Protection

Other Protective Clothing or Equipment

Work/Hygienic Practices

MOTOR VEHICLE SAFETY PROGRAM

Safe operation of motor vehicles is the result of safety planning and action, not chance.

The principal factors of motor vehicle accidents are driver failure and vehicle failure. OSHA will be concerned with both of these factors. Therefore you should establish a motor vehicle safety program as well as a shop safe practices program. Be sure to include specific information on: (a) driver selection, training, and supervision; (b) safety meetings; (c) preventative maintenance; (d) fleet accident data; (e) department of transportation requirements; and (f) OSHA regulations — Subpart N 1910.177-178.

DRIVER SELECTION, TRAINING, AND SUPERVISION

The following criteria are recommended for *selection* of all drivers. The employee:

Should be at least twenty-one (21) years old.

Should be able to read and speak English in order to converse with the public.

Should be checked out and must be qualified to operate the type of equipment assigned.

Must undergo physical examinations to meet D.O.T. regulations.

Must hold a current and valid Operator's License.

Must have an acceptable past driving record. Past violations, if any, should be investigated.

For the safe operation of a fleet of road vehicles, regardless of how small, a *training program* is needed. The following procedures are suggested:

Maintain written records of **all** employee training.

Arrange to have two (2) of your drivers attend a Driver's Training School. (Contact your local Trucking Association.)

These trained drivers should be used to train the balance of the present drivers.

All new drivers should be trained by your training officers.

Driver's test used by D.O.T. should be incorporated in your program. This can be used by the training officers.

One person in the organization should be assigned the responsibility to *supervise* the operations of all commercial equipment. His or her duties should be to:

Assign loads.

Route drivers.

Plan loads and delivery.

Keep written daily records of the operations of all trucks.

See that drivers maintain logs when required.

Maintain a **complete** accident record file.

SAFETY MEETINGS FOR COMMERCIAL DRIVERS

Safety meetings should be held for truck drivers at least quarterly. Drivers should be required to attend all safety meetings. Programs for meetings should include outside traffic authority. Vehicle accidents for the past quarter should be reviewed, and hazards of the season should be stressed.

PREVENTATIVE MAINTENANCE

A complete preventative maintenance program should be installed. This should cover all equipment.

The fleet supervisor should implement the program and keep records for daily checks. The details for this type of program are available from: truck dealers, trucking associations, and insurance companies. A qualified mechanic should make these checks.

FLEET ACCIDENT DATA

Fleet accident data should be maintained, with records as complete as those for personal injury. Accidents must be analyzed as to cause, and steps must be taken to eliminate the cause, thereby preventing future accidents with similar causes.

The fleet safety record should be included in the Safety Committee agenda. All drivers should be aware of the company fleet safety record.

U.S. DEPARTMENT OF TRANSPORTATION REQUIREMENTS

Section 395.8 of the D.O.T. Manual states:

> *"Every motor carrier shall require that a driver's log Form MCS-59 shall be made in duplicate by every driver who operates a motor vehicle. Failure to make logs, failure to make required entries therein, falsification of entries or failure to preserve logs shall make both driver and carrier liable to prosecution. Drivers' logs shall be prepared and detailed complete."*

Exception:

> *"The logging requirement shall not apply:*
>
> *"To any driver regularly employed who drives wholly within a fifty (50) mile radius of the home terminal where he reports to work.* ***PROVIDED:*** *The carrier employing such driver maintains and retains for a period of one (1) year accurate and true records showing total hours driver is on duty per day; time he reports; time he is released from duty.*
>
> *"To drivers of motor vehicles having not more than two (2) axles and whose gross load does not exceed 10,000 lbs—unless such vehicle is used to transport passengers, explosives or other dangerous article which requires vehicle to be marked under Hazardous Materials Regulations."*

The trucks that come under this rule should conform to D.O.T. Regulations for safety equipment and logging. Copies of the D.O.T. Safety Regulations, as well as the necessary forms, should be obtained by the Safety Coordinator. Forms are available from the American Trucking Association, Safety Dept. 2200 Mill Road, Alexandria, VA 22314 (703) 838-1700. The recordkeeping requirements will justify appointing a fleet supervisor.

BASIC ELEMENTS OF A RESPIRATORY PROTECTION PROGRAM (Respiratory Protection 1910.134)

The following is based on the National Institute for Occupational Safety and Health (NIOSH) recommendations* as an outline which can be used to develop a written plan for a respirator program which will comply with OSHA regulation 1910.134. The standard requires employers to provide appropriate respiratory protection for employees who may be exposed to airborne toxic materials in excess of acceptable levels, in the absence of feasible engineering controls, or if administrative controls are not able to reduce employee exposure to acceptable levels. Respiratory protection is required when working in oxygen deficient atmospheres — where oxygen content is insufficient.

ESTABLISHMENT OF THE RESPIRATORY PROGRAM

Once it is established that a respiratory program is required or desired, it is essential to designate a person who will be responsible for administering and coordinating the various aspects of the program. Preferably, the individual selected should be a safety engineer, industrial hygienist, or a physician. In a small company, where respirator usage is limited, the program may be directed by the owner, foreman, or supervisor. The person assigned the responsibility should have full management support, and be able to make decisions based on an evaluation and understanding of workplace hazards.

The individual designated to head the program is required to develop standard operating procedures which should include the following:

- The basis for selection of respiratory protection equipment.
- Provisions for medical screening of employees assigned to wear respiratory equipment to determine that they are physically or psychologically able to wear respirators.
- Provisions for assigning respiratory protective equipment for exclusive use, where practical.
- Provisions for proper fit testing of equipment.
- Provisions for regular cleaning and disinfecting of the respiratory equipment.
- Provisions for proper storage.
- Provisions for periodic inspection.
- Provisions for repairs and adjustments.
- Provisions for periodic evaluation by the administrator of the program.
- Provisions for a training program to familiarize the employee(s) with properly using the respiratory protective equipment, and its limitations.

A program which includes the above *must* be instituted as a control measure only after it has been determined that:

1. Employee exposure to chemical agents exceeds established limits (OSHA standards).
2. Engineering controls are not feasible, or
3. Engineering controls are in the process of being implemented.

CONSIDERATIONS FOR RESPIRATOR SELECTION PROCEDURES

Properly selecting respiratory protective equipment includes three basic steps:

1. Identification of the hazard
2. Evaluation of the hazard
3. Selection of the appropriate (approved) respiratory equipment based on steps one and two

HAZARDOUS ATMOSPHERES

When a survey to determine the need for respirators is to be undertaken, it is important to know something about the different kinds of hazardous atmospheres which may require the use of respirators.

*(NIOSH) Publication No. 78-193A, GPO #017-033-00326-2.

1. *Gaseous Contaminants*

   Gaseous contaminants are generally invisible and can combine with the air we breathe. They are usually of two types:

   a. *Gases* such as carbon dioxide are the normal form of some substances. These are solids, or liquids at lower temperatures or much higher pressures than commonly found in an industrial environment. Carbon dioxide is a gas at room temperature, a solid "dry ice" at low temperatures, or a liquid in pressurized tanks.

   b. *Vapors* are like gases. They are formed by evaporation of liquid substances such as acetone or trichloroethylene.

2. *Particulate Contaminants*

   Particulate contaminants are made up of tiny particles of a substance. These particles are often so small that they float around in the air and are easily inhaled. There are three types of particulates:

   a. *Dusts* — solid particles produced by grinding, crushing, and mixing of powder compounds. Example — sand and plaster dust.

   b. *Mists* — tiny liquid droplets given off when a liquid is sprayed, mixed, or agitated. Acid mists around dip tanks used for metal cleaning, and oil mists near newspaper printing presses are two examples.

   c. *Fumes* — solid condensation particles of extremely small particle size. Fumes are generally present in the air near soldering, welding, and brazing operations, as well as near molton metal processes such as casting and galvanizing.

3. *Combination of Contaminants*

   It is important to note that gaseous and particulate contaminants can frequently occur together. As an example, paint spraying operations produce paint mist, which is a particulate, and solvent vapors which are gaseous.

4. *Oxygen Deficient Atmospheres*

   Oxygen deficient atmospheres are classified as immediately dangerous to life. Typical examples of oxygen deficient locations or situations are silos, petrochemical tanks, holds of ships, and similar types of confined and usually poorly ventilated spaces. There are also situations which require that an oxygen deficient atmosphere be maintained. One example is storage of fruit which may require warehouse facilities in which there is a high carbon dioxide concentration and a low presence of oxygen. Oxygen deficient atmospheres can occur in two different ways:

   a. "Use up" of oxygen by chemical reaction, such as what happens in a fire.

   b. Oxygen replacement by another gas. As an example, as a room with normal air (approximately 21% oxygen) fills up with a gas such as helium, much of the oxygen would be displaced and only a small amount would remain for breathing.

5. *Immediately Dangerous to Life or Health*

   This term describes very hazardous atmospheres where employee exposure can cause:

   a. Serious injury or death within a short time, e.g., exposure to high concentrations of carbon monoxide or hydrogen sulfide.

   b. Serious delayed effects, e.g., exposure to low concentrations of radioactive materials or cancer causing agents.

HAZARD EVALUATION

A walk-through survey of the plant is the next step in the respirator selection process. The aim of the survey is to identify employee groups, processes, or worker environments where use of respiratory protective equipment may be required.

1. The walk-through Hazard Survey is to identify and measure any hazardous substances or conditions. The survey can be facilitated by use of the Hazard Evaluation Form (Figure 1).

RESPIRATOR PROTECTION PROGRAM

Hazard Evaluation Survey Form

Company _____

Civision _____

Department _____

SURVEY DATE
BY
PAGE of

This form should be filled out as completely as possible during the walk-through survey. Enter any details about the work environment which could affect the choice of respiratory protective equipment, or to support a decision *not* to require use of such equipment.

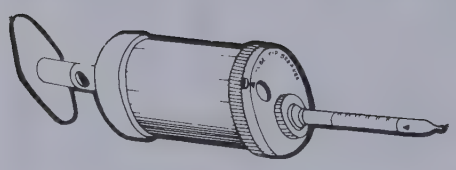
EMPLOYEE	JOB DESCRIPTION	Respiratory Equipment Required by OSHA Standard	Exposure Substance(s)	O Defct Atm		Measured Concntrtn	OSHA Limit	Resprtry Prtctn Requrd		Respiratory Equipment Type-SCP	REMARKS
				Yes	No			Yes	No		

FIGURE 1

MECHANISMS FOR DETERMINATION OF CONCENTRATIONS OF HAZARDOUS SUBSTANCES

A. EVALUATION METHODS

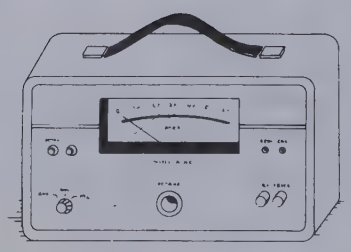
1. Gaseous and Vapor Contaminants



Detection Tube Measurement Equipment

Gaseous contaminants are usually measured in parts per million (ppm) — parts of contaminants *per* million parts of air, or parts of contaminants per billion parts of air (ppb). A common *screening* device used is the detector tube. These tubes are available for many of the gases found in the work environment — from several different manufacturers. If possible, only detector tubes approved by NIOSH for the specific contaminant should be used for determination of gas and vapor concentrations.

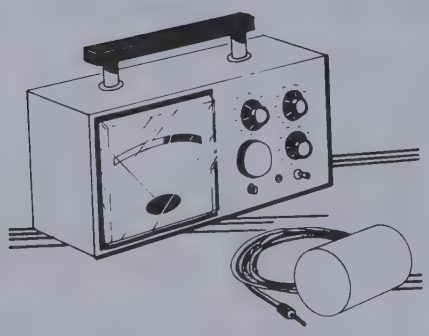
2. Particulate Contaminants



Direct-Reading Instrument for Carbon Monoxide

A majority of regulated particulate contaminants are usually measured in milligrams per cubic meter (mg/m^3) — milligrams of contaminant per cubic meter of air, million particles per cubic foot (mppcf) — millions of particles per cubic feet of air, e.g., 5mppcf would be five million particles per cubic foot of air, or fibers per cubic centimeter (fibers/cc) — fibers of contaminant per cubic centimeter of air. In contrast to the availability of measuring devices for gas and vapor contaminants, few direct-reading instruments are available for measurement of particulates. Those that are available indicate the *total* dust or *respirable dust concentration* and do not distinguish between the various materials making up the total dust concentration.

3. Oxygen Deficient Atmospheres



Oxygen Indicator

There are several direct-reading instruments for measurement of oxygen content.

B. INTERPRETATION OF MEASUREMENTS

The measured concentration (in appropriate units) is then compared with either the permissible exposure level (PEL), mandated in OSHA regulations, or the threshold limit value (TLV), recommended by the American Conference of Governmental Industrial Hygenists (ACGIH). These values, as determined by these groups, are the maximum concentration to which a worker may be exposed day after day without adverse affects.

Excerpted from NIOSH's *Respiratory Protection Manual — An Employer's Manual.*

PURCHASE OF RESPIRATORY EQUIPMENT

When purchasing respiratory protective equipment, be sure to specify equipment *approved* for the particular contaminant involved. An approved respirator is one that has been tested and found to meet *minimum* standards by the Mine Safety and Health Administration (MSHA) and the National Institute for Occupational Safety and Health (NIOSH). If only one brand of respirator is approved for a particular hazard, then that brand is considered to be "available" and must be used.

NIOSH approved respirators must show the following:

- An assigned identification number on each unit (e.g., TC-23C-327).
- A label identifying the type of hazard the respirator is approved to protect against.
- Information on the label which indicates limitations, and identifies component parts approved for use with basic unit.

MEDICAL ASPECTS OF RESPIRATOR EQUIPMENT USAGE

The use of any respirator may impose some physiological stress on the user. When using an *air-purifying respirator*, breathing can become more difficult because the flow of air is impeded by a filter or cartridge. On an *open circuit pressure demand respirator* the wearer has to exhale against significant resistance of the exhalation valve.

Self-contained breathing apparatus (SCBA) presents the burden of bulk and weight. When using an airline respirator, the wearer might have to drag long lengths of air hose.

A medical examination is recommended to determine if the employee is medically able to use respiratory protective equipment without aggravating a preexisting physical or medical problem. (See page 5—53 for NIOSH General Information regarding the Medical Program.)

FITTING RESPIRATORY EQUIPMENT

It is important that the respiratory protective equipment be properly fitted to the employee when issued. The employee should also have a good understanding of the importance of a sure fit, and how to check the fit whenever the equipment is to be worn.

TWO TYPES OF FITTING TESTS

Two types of fitting tests are qualitative and quantitative.

Qualitative Tests

Qualitative tests are generally fast and easy to perform. They make use of chemicals with a distinct odor or irritant quality that might be detected by the wearer if the respirator does not provide a proper fit. These tests are administered in a controlled test enclosure or chamber. The employee who is to undergo a test should put on the respirator in an area away from the test enclosure to avoid contamination of the respirator or its components. The following are some qualitative fitting tests:

1. *Isoamyl Acetate*, a substance with a banana-like odor, is generally used in testing the facepiece fit of *organic vapor cartridge/canisters*. In conducting the test a cotton wad saturated with the substance is placed inside the chamber. During the test, the user should try to perform the following:
   - Normal breathing
   - Deep breathing
   - Head movement, side-to-side and up-and-down, to approximate activities that may take place on the job.
   - Additional exercises that would most nearly represent movements or activities associated with anticipated work conditions, such as bending or stretching.

   A major problem with use of isoamyl acetate tests is that the odor threshold varies widely among individuals. Also, the individual's sense of smell might be dulled and could deteriorate rapidly during the test so that the wearer would only be able to detect high concentrations of the vapors.

2. *Irritant Smoke Test* is used to test facepiece fit of *particulate filter* respirators.

   The test can be used for both air-purifying and atmosphere-supplying respirators.

   The test substance, stannic chloride or titanium tetrachloride, is an irritant. These substances are available commer-

cially in the test, the tube ends are broken and air is forced through, usually with a squeeze bulb, to cause a dense, irritating smoke to be emitted. In this test, the employee (user), after fitting and adjusting the respirator, steps into the test enclosure and the irritant smoke is "sprayed" through a test hole into the enclosure. If the respirator fits correctly, the user will not notice or be affected by the irritant. If the user detects any of the irritant smoke, it is an indication that the fit is faulty, and adjustments or replacement of the respirator is required. This test has a distinct advantage in that the wearer usually reacts involuntarily to any leakage around the face seal by coughing or sneezing. There is little likelihood of an individual giving a false indication of proper fit.

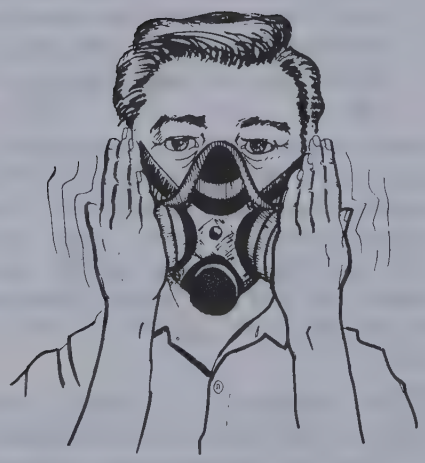
Irritant Smoke Test

A word of caution — extra care is required in performing the irritant smoke test because the aerosal used can be highly irritating to the eyes, skin, and mucous membranes.

Other qualitative fit tests — the positive pressure fit test and the negative pressure fit test — apply only to the air-purifying respirators. They can be used as a quick check of the fit of the respirator facepiece. The test is usually made before beginning work or during work in a hazardous atmosphere.

3. *Negative Pressure Test*

In this test, the user a) closes off the inlet of the canister, cartridge, or filter by covering with the palm or squeezing the breathing tube to close off passage of air, b) inhales so the facepiece collapses slightly, and 3) holds breath for about 10 seconds. If the facepiece remains slightly collapsed and no inward leakage is detected, the respirator is probably maintaining a tight enough fit.



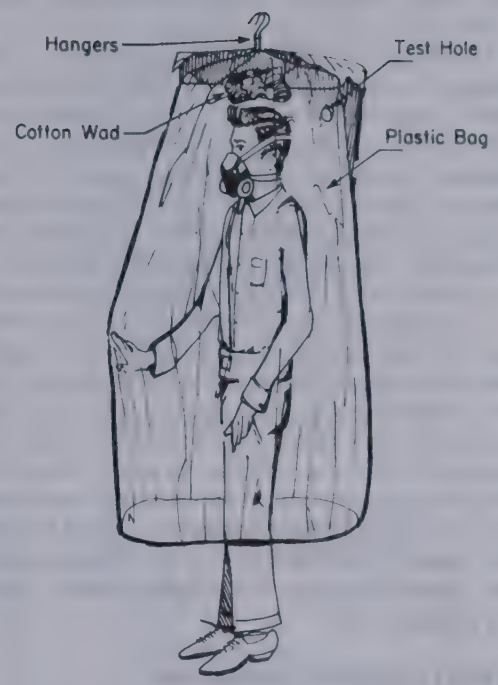
Negative Pressure Test

4. *Positive Pressure Test*

This test is conducted by closing off the exhalation valve and gently exhaling into the facepiece. The fit is considered satisfactory if slight positive pressure can be built up inside the facepiece without any outward leakage. This test can easily be used on respirators which have valve covers with single small ports that can be closed off by the palm or a finger. Special care is needed if this test is attempted on respirators which may require removal and replacement of the exhalation valve covers, as this activity can easily disturb the fit and cause leakage.

Quantitative Tests

In quantitative testing, respirators have to be fitted with a sampling probe which is to serve as a means of continual removal of air samples from the facepiece. This test is only to be used to test a type of respirator rather than one which is to be assigned to an employee, since introduction of the sampling probe requires creation of an opening in the facepiece. In conducting the test, the wearer is placed in an atmosphere containing a detectable, relatively nontoxic gas, vapor, or aerosol. Any leakage detected by the testing instruments would be shown as a percentage of the test atmosphere outside the respirator. Any leakage would be noted as a "percent of penetration," or simply "penetration." Test mediums introduced into the test chamber in quantitative fit tests are of the aerosol types and dispersed either as dry particulates or liquid particles. Sodium Chloride (NaCl) is generally used if a dry particulate is desired for the test; Dioctyl Phthallate (DOP) for testing of liquid particles.



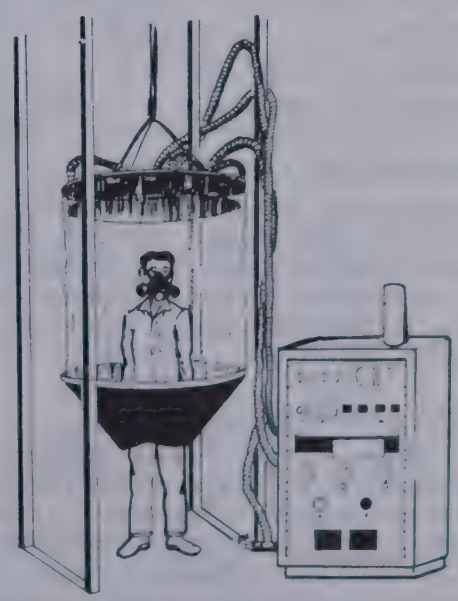
TEST ENCLOSURE

TEST ATMOSPHERES — TESTING METHODS

The regulations require that the user test the facepiece to face seal of the respirator and to wear it in a test atmosphere or enclosure which:

1. The user can enter while wearing the equipment, and
2. A "test" contaminant (of low toxicity) can be introduced.

Special test chambers are available commercially. A simple qualitative fit test enclosure can easily be made by use of a plastic bag, such as a dry cleaners garment bag, hangers, and a wad of cotton.



Quantitative Test

FITTING TEST PROBLEMS

Facial hair (beards, sideburns, stubble, or other facial hair growths) can interefere with and prevent a good seal. The problem can be critical when nonpowered air-purifying respirators are used. Negative pressures developed in facepieces of these types of respirators during inhalation can cause leakage of contaminant into the facepiece when there is a poor seal. Individuals with excessive facial

hair which can interfere with and prevent tight sealing should not be permitted to wear a respirator.

Corrective lenses with temple bars or face straps should not be used when a full-facepiece respirator is worn. If respirators are needed for individuals who must wear eyeglasses, provisions should be made for eyeglasses to be installed in the facepieces. There are kits available for this purpose. Care should be taken that the installation and fitting be accomplished by a qualified person.

A properly fitted respirator may stretch the skin around the eyes and if the user is wearing contact lenses, the lenses could fall out. Additionally, contaminants that may penetrate the respirator may get under the contact lens and create severe discomfort and bring on a reaction for the user to remove the facepiece. Such a reaction could be fatal in a lethal environment. It is recommended that contact lenses not be worn while wearing a respirator.

MAINTENANCE PROGRAM

Proper maintenance of respirators is an important element of a respirator program. It is recommended that the program follow the equipment manufacturer's instructions and that there be provisions for:

- Cleaning and disinfecting of equipment
- Storage
- Inspection for defects
- Repair or replacement

CLEANING AND DISINFECTING

Respirators which are routinely used should be cleaned and disinfected daily. Workers who are required to maintain their own respirators should be trained in the proper methods of cleaning, disinfecting, inspection, and storage.

Cleaning Methods

Cleaning and disinfecting solutions are available to effectively clean the equipment and to prevent bacterial growth. The respirator should be washed with a detergent solution in warm water, scrubbed with a brush, rinsed thoroughly in clean water, and allowed to dry in a clean area. If a large number of respirators are to be cleaned, a clothes washer may be used. The washer should have a rack installed to hold facepieces in a fixed position to prevent contact with the agitator.

Detergents and Disinfectants

Avoid using organic solvents which can cause deterioration to rubber facepieces. Detergents which contain a batericide are recommended. In the absence of a combined solution, the detergent wash should be followed by a disinfectant rinse.

Disinfectant Solution

NIOSH suggests that reliable disinfectant solutions can be made using available household-type material:

- Hypochlorite solution (50 ppm of chlorine) made by adding approximately 2 tablespoons of chlorine bleach per gallon of water.
- Aqueous solution of iodine (50 ppm) made by adding approximately 1 teaspoon of tincture of iodine per gallon of water.

A two minute immersion in one of these disinfectant solutions is sufficient and will not damage the rubber or plastic in the facepieces. As an added precaution it is advisable to check with the equipment manufacturers for their recommendation on the proper temperature for the solutions.

NIOSH also suggests that if a washing machine is used, the disinfectant be added to the rinse cycle. The amount of disinfectant to be added can be determined by measuring the amount of water in the machine.

Rinsing

Clean rinsing water (120°F maximum) should be used to remove all traces of detergent, cleaner, sanitizer, and disinfectant. Thorough rinsing is important to prevent dermatitis.

Drying

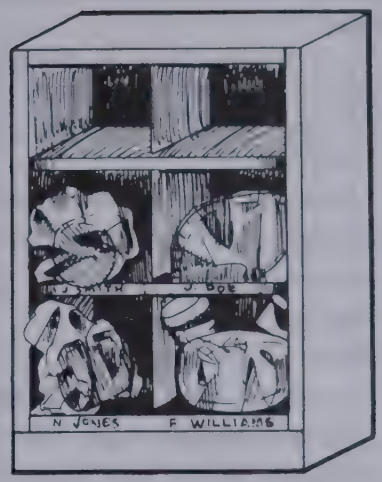
Respirators may be placed on a clean surface to dry, or may be suspended, like drying clothes, from a horizontal support such as a

wire or clothesline.

Storage

Respiratory protective equipment *must* be stored in a way that will assure protection from dust, sunlight, heat, cold, moisture, and damaging chemicals. Cleaned and dried respirators should be kept individually in heat sealed or resealable plastic bags. Storage should be in a single layer with the facepieces and exhalation valve in a normal position.

Employees should be cautioned against leaving respirators unprotected on a workbench, in a tool cabinet, or among heavy tools, which can cause damage to working parts or distortion of the facepiece.



INSPECTION SCHEDULES AND PROCEDURES

Respiratory protective equipment must be inspected before and after each use and during cleaning.

Equipment designated for emergency use must also be inspected at least monthly.

Self-contained breathing apparatus must be inspected at least monthly.

What to Check for During Inspection:

Disposable respirators:

- Holes in filter
- Elasticity of straps
- Deterioration of straps and metal nose clip

Air-purifying respirators

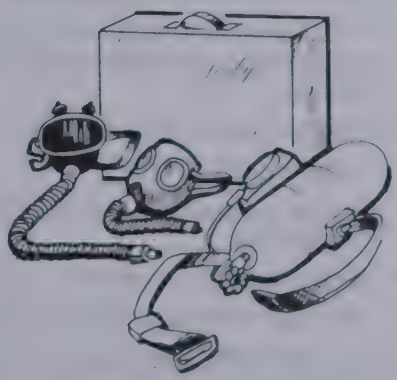
Check facepiece for:

- Dirt.
- Cracks, tears, or holes.
- Distortion of facepiece.
- Cracked, scratched, or loose fitting lenses.

Headstraps should be checked for:

- Breaks or tears.
- Loss of elasticity.
- Broken buckles or attachments.
- Worn serrations on head harness which might allow facepiece to slip.

Examples of Storage Facilities



Storage Chest for SCBA

Inhalation and exhalation valves should be checked for:

- Dust particles, dirt, or detergent residue on valve and valve seat.
- Cracks, tears, or distortion in valve material.
- Missing or defective valve covers.

Filter elements should be checked for:

- Proper filter for the hazard.
- Approval designation.
- Missing or worn gaskets.
- Worn threads on filter and facepiece.
- Cracks or dents in filter housing.
- Deterioration of gas mask cannister harness.
- Service life indicator, or end of service date (find out from equipment manufacturer if there are indicators or how to determine "end of service").

Check corrugated breathing tube (gas mask) for:

- Cracks or holes.
- Missing or loose hose clamps.
- Broken or missing end connectors.

For Atmosphere-Supplying Respirators:

Check facepiece, headstraps, valves, and breathing tube for possible defects as listed for air-purifying respirators.

Hood, helmet, blouse, or full suit should be checked for:

- Rips or torn seams.
- Headgear suspension.
- Cracks or breaks in faceshield.
- Protective screens that are intact and fit correctly over faceshields, hoods, or blouses.

Air supply systems should be checked for:

- Breathing air quality.
- Breaks or kinks in air supply hoses and fittings.
- Tightness of connections.
- Settings of regulators and valves.
- Correct operations of air-purifying elements and alarm for carbon monoxide or high temperatures.

Consult equipment manufacturer for necessary parts and instructions on replacement and repair procedures.

OPERATING PROCEDURES IN HAZARDOUS AREAS

Dangerous Atmospheres

A standard operating procedure for work in high hazard areas must be written if it is anticipated that respiratory equipment is to be used in atmospheres "immediately dangerous to life or health." The standard procedure must cover at least:

- Training in use of the proper equipment for employees designated to enter dangerous atmospheres.
- Employees so designated *must* be equipped with safety harnesses and safety lines.
- Provisions for a standby person, equipped with proper rescue equipment to be present and ready in a nearby safe area for emergency rescue if needed.
- Provisions for communication between the employee in the dangerous atmosphere and the standby rescue person. Communication can be by voice, visual signal, telephone, radio, signal line, or other suitable method.
- Toxicology information.
- Emergency phone numbers listed so as to be readily available.

Confined Spaces

Confined spaces and enclosures which may present difficulties for employees to work in or to get out of, could be storage tanks, tank cars, boilers, sewers, tunnels, pipelines, or similar structures. Often the ventilation is extremely poor in such places and there may also be a presence of toxic air contaminants and a deficiency of oxygen. Here are some of the special precautions which should be taken:

Test for hazards before entry:

- Before entering a confined space, tests should be made for presence and concentration of any flammable gas, toxic airborne particulate, vapor, gas, and level of oxygen in the atmosphere.

OXYGEN DEFICIENT ATMOSPHERES

An atmosphere that does not contain enough oxygen to support the body metabolic process is called "oxygen deficient."

A. GENERAL PRINCIPLES

1. Normal Atmosphere

Earth's atmosphere has an essentially fixed composition of the following gases in the dry state.

Gas	*Volume*
Nitrogen	78.09
Oxygen	20.95
Argon	0.93
Carbon Dioxide	0.04

Normal air always contains small amounts of other gases such as neon, helium, and krypton. Water vapor, an important constituent of the normal atmosphere, may be up to 5% of the total volume.

2. Definition of Oxygen Deficient Atmosphere

An accurate description of an oxygen deficient atmosphere (ODA) is important for strictly physiological reasons and also for proper respirator selection. However, no one definition (value) has been universally accepted.

DEFINITIONS OF OXYGEN DEFICIENT ATMOSPHERES

Source or Standard	*Oxygen Content*
ACGIH Threshold Limit Value (1973)	18.0%
Federal Regulations 29 CFR 1915.51 (Maritime Standards)	16.5%
29 CFR 1910.94	19.5%
ANSI Standards Z88.2-1969 (Respiratory Practices)	16.0%
Z88.5-1973 (Firefighting)	19.5%

3. Effects

The symptoms of oxygen deficiency depend on the oxygen concentration present. The table indicates physiological effects for varying oxygen content.

PHYSIOLOGICAL EFFECTS OF OXYGEN DEFICIENCY

O_2 Vol. % At Sea Level	
16-12%	Increased breathing volume. Accelerated hearbeat. Impaired attention and thinking. Impaired coordination.
14-10%	Very faulty judgment. Very poor muscular coordination. Muscular exertion causes rapid fatigue that may cause permanent heart damage. Intermittent respiration.
10-6%	Nausea. Vomiting. Inability to perform vigorous movement, or loss of all movement. Unconsciousness, followed by death.
Less than 6%	Spasmatic breathing. Convulsive movements. Death in minutes.

Excerpted from NIOSH's *Respiratory Protection Manual — An Employer's Manual*

- If there is evidence of a flammable substance force ventilation, then force ventilation is to be introduced to keep the concentration below the lower explosive limit. Continuous monitoring is to be maintained to measure the percent of contaminant and/or oxygen while individuals are working within.
- Only individuals who have been trained for work in confined spaces should be allowed to enter.
- Respirator equipment appropriate for the condition must be worn.

Standby rescue person(s) with proper rescue equipment including SCBA, must be present outside the confined space to maintain communication with workers inside, and be ready for possible emergency rescue.

PRECAUTIONS FOR LOW AND HIGH TEMPERATURE

Low Temperatures

In low temperatures the lenses of full-facepiece equipment may fog due to condensation of vapor in exhaled breath. Fogging can be reduced by coating the inner lens surface with an anti-fogging compound. Some manufacturers offer a noseclip for insertion into the respirator which would deflect the exhaled air towards the exhalation valve.

Low temperatures can also cause the exhalation valve to freeze to the valve seat causing increased pressure in the facepiece. Freezing up the valve requires special care to avoid damage to the rubber diaphram.

Hot Environments

Use of respirators in hot environments increases the stress on the user. A lightweight respirator with low breathing resistance can minimize the stress. An airline-type atmosphere-supplying respirator equipped with a vortex tube can be used.

EMPLOYEE TRAINING

Trainees usually retain only about 20% of what they hear, 40% of what they see, and perhaps 70% of what they see and hear together. Best results can be achieved by reinforcing the presentation with a combination of lectures, audiovisual material, and hands-on demonstrations. Here are some suggestions:

- Break the training sessions into 30-45 minute segments.
- Use a chalkboard or flip chart for emphasizing subject sequence and major points.
- Present slides or films. These can be obtained from the National Safety Council, trade associations, or equipment manufacturers and suppliers.
- Describe personal experiences or examples related to your operations.
- Have on hand examples of the types of respirators used at your facility.
- Discuss company operating procedures.
- Include instruction materials supplied by the equipment manufacturers and supplier.
- Point out applicable OSHA regulations. See checklists beginning on page I-01 (Subpart I-1910.134).

TRAINEE PARTICIPATION

It is important to establish an open exchange of information and to encourage questions between instructors and trainees. The following comments can be helpful at the start of the training session:

"Your full participation is needed during this session to help assure your own safety and that of your fellow workers in use of respiratory equipment.

- "Don't be afraid to ask questions. If you don't understand what is being discussed you may miss an important point that can result in serious harm to yourself or others.
- "Share with us any personal involvement or any incidents pertaining to the specific area discussed.
- "Give us the benefit of your experience. If you are aware of better methods to reduce hazardous conditions, now is a good time to discuss them.

- "Lastly, if you feel there may be additional guidance or information we can provide, please identify the areas for us."

SOURCES OF ASSISTANCE

If in-house qualified personnel are not available, outside assistance should be obtained to determine the extent of employee exposure to hazardous substances. It may also be desirable to engage the services of qualified professionals to assist in developing, establishing, and auditing the respiratory protection program.

Federal or State Consultation Services

Contact your regional OSHA office or your state agency for address and phone of consultation service.

NIOSH

Check your local telephone directory for DHEW-NIOSH (Department of Health Education and Welfare) under U.S. Government.

Private Consultation Services

A list of consultants in your area can be obtained by writing to American Industrial Hygiene Associates, 475 Wolf Ledges Parkway, Akron, OH 44311.

ISSUANCE AND ASSIGNMENT OF RESPIRATORS

Where practical, employees should be assigned protective equiment for their exclusive use. A system of user cards and a journal or log can be established to keep track of all employees who are issued respiratory protective equipment. The card, issued by the program administrator, shows what respirator the user is to wear and the contaminant to be protected against. A record of the card being issued is kept in the journal. The user can only obtain the respirator specified on the card. Each of the permanently assigned respirators should be marked or labelled to indicate the employee to whom it is assigned.

(COMPANY NAME, ADDRESS, PHONE NO.)

RESPIRATOR USER CARD NO.

Name

Operation

Contaminants / Hazards / Process

Respirator Type	Issue Date	Explr. Date

Approved By:

See recommended log on page 5—44

(Company Name / Address)

RESPIRATOR PROTECTION PROGRAM USER CARD JOURNAL

Page No.

CARD NO.	ISSUED TO	HAZARD	RESPIRATOR TYPE	DATE ISSUED	EXPIRATION DATE	APPROVED BY

RESPIRATORY PROTECTIVE EQUIPMENT

I. AIR-PURIFYING — PARTICULATE REMOVING FILTER RESPIRATORS

A. Description

These are generally called "dust," "mist," or "fume" respirators, and by a "filtering" action remove particulates before they can be inhaled.

1. Single-use, dust

The single-use respirator is a respirator which is completely disposed of after use. They are for individual use and should be discarded when resistance becomes excessive or the respirator is damaged. Generally, these respirators are approved only for pneumoconiosis or fibrosis producing dust such as coal dust, silica dust, and asbestos.

2. Quarter-mask dust and mist, half-mask dust and mist

The quarter-mask covers the mouth and nose; the half-mask fits over the nose and *under the chin.* The half-mask usually produces a better facepiece to face seal than does the quarter-mask and is therefore preferred for use against more toxic materials. Dust and mist respirators are designed for protection against dusts and mists whose TLV is greater than .05mg/M^3 or 2 mppcf.

3. Quarter-mask fume; half-mask fume

These masks, similar to those in 2 above, utilize a filter element which can remove metal *fumes* in addition to dusts and mists from the inhaled air. The filters are approved for metal fumes having a TLV *above* .05mg/M^3 or 2 mppcf.

4. Half-mask, high efficiency

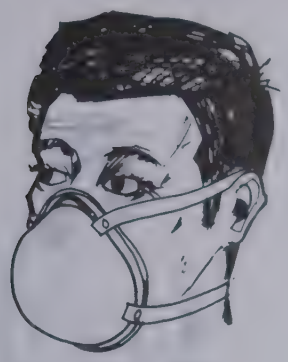
These masks are the same as in 2 and 3, above, but use a high efficiency filter. Because of this high efficiency filter, they can be used against dusts, mists, fumes and combinations of those whose TLV is *less* than .05mg/M^3 or 2 mppcf.

5. Full facepiece

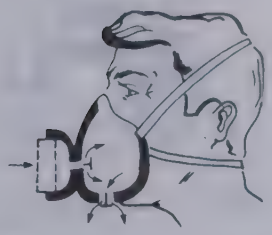
Full facepiece respirators cover the face from the hairline to below the chin. In addition to providing more protection to the face, the full facepiece gives a better seal than do the half- or quarter-masks. These respirators provide protection against dusts, mists, fumes, or any combination of these contaminants depending upon the type of filter used.

6. Powered dust, mist, and fume respirators

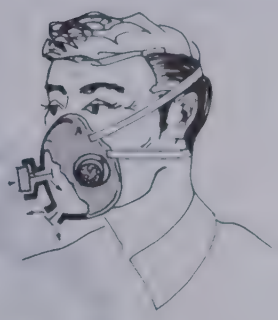
These respirators use a blower that passes the contaminated air through the cartridge or canister where the contaminant is removed and passes the purified air into the facepiece. The air purifying element can be a filter to remove particulates, a cartridge or canister to remove gases or vapors, or a combination to remove both. The face covering can be a half-mask, full-face mask, or hood or helmet.



Single-Use Respirator



Quarter-mask Respirator



Half-mask Respirator

Full Facepiece Respirator

Excerpted from NIOSH's *Respiratory Protection Manual — An Employer's Manual*

Powered Air-Purifying Respirator — Back View

The advantage to using a powered air-purifying respirator is that it supplies air at a positive pressure within the facepiece, hood, or helmet, so that any leakage is outward. The protection provided depends on the air-purifying element and the type and concentration of the contaminants.

Powered respirators must deliver at least 4 cubic feet per minute (cfm) to a tight fitting facepiece such as a mask and at least 7 cfm to a loose fitting helmet or hood. If the powered respirator is battery operated, it should provide the airflows mentioned for at least 4 hours without having to recharge the battery.

B. Approvals

NIOSH approves air-purifying and powered air-purifying particulate removing respirators to protect the wearer against one or more of the following hazards:

- Dust exposure, where the OSHA allowable daily exposure for the dust is not less than 0.05mg/M^3;
- Mist exposure, where the OSHA allowable daily exposure for the mist is not less than 0.05 mg/M^3 or 2 mppcf;
- Metal fume exposure, where the OSHA allowable daily exposure for the fume is not less than 0.05 mg/M^3;
- Dust, fume and mist exposure, where the OSHA allowable daily exposure for the dust, fume, or mist is less than 0.05 mg/M^3;
- Exposure to radon daughters (radioactive material) and radon daughters attached to dusts, fumes, and mist;
- Exposure to asbestos containing dusts or mists; and
- Exposure to dusts or mists which cause the formation of scar tissue in the lungs (pneumoconiosis and fibrosis producing).

NOTE: No approved dust, fume, or mist respirator can be worn with the "facelets" or other cloth or plastic cover between the facepiece and face. These covers introduce excessive leakage, and also negate the approval.

Powered Air-Purifying Respirator — Front View

C. Limitations

1. Air-purifying respirators do *not* provide oxygen, so they must *never be worn in oxygen deficient atmospheres.*

2. Particulate removing air-purifying respirators offer *no* protection against atmospheres containing contaminant gases or vapors.

3. These respirator types should not be used for abrasive blasting operations.

D. Problems

1. The air flow resistance of a particulate-removing respirator filter element increases as the quantity of particles it retains increases, thus increasing the breathing resistance. *As a rule of thumb,* when comfortable breathing is impaired because of dust build-up, the filter should be replaced.

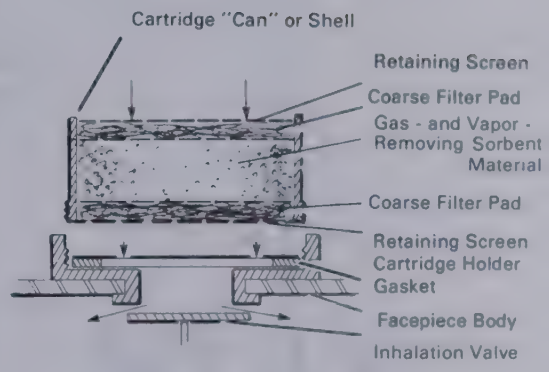
2. Performance of some filter materials is affected by open storage in very humid atmospheres. Care should be taken in storing filter elements.

Excerpted from NIOSH's *Respiratory Protection Manual — An Employer's Manual.*

II. AIR-PURIFYING — CHEMICAL CARTRIDGE AND CANISTER RESPIRATORS, GAS AND VAPORS

A. Description

Vapor and gas-removing respirators use cartridges or canisters containing chemicals to trap or react with specific vapors and gases and remove them from the air breathed. The basic difference between a cartridge and a canister is the volume of the sorbent. Generally, a "cartridge" refers to a chemical filtering element which attaches directly to the facepiece, whereas a "canister" refers to the chemical filter element held in a harness and which is connected to the facepiece via a corrugated breathing tube. Some typical cartridge and canister respirators are discussed below.



Typical Chemical Cartridge

1. Half-mask and quarter-mask respirators

These are available for protection against single chemicals such as ammonia or against entire classes such as organic vapors. Be sure to read the label on the cartridge or canister since it tells what the cartridge or canister protects against, what the maximum concentration in which the element can be used, and in some instances, the service life or expiration date of the element.

2. Full facepiece

The full facepiece respirator may use a canister or cartridge(s) as the protective element. The front, back, and chin-mounted full-facepiece canister respirators are also referred to as "gas masks."

B. Approvals

NIOSH approves chemical cartridge or canister respirators to protect the wearer against many of the organic vapors, acid gases, and gaseous contaminants encountered in the work environment. Consult with a manufacturer or distributor of respiratory protective equipment to determine what type of cartridge or canister is appropriate for the contaminant and concentration.

Excerpted from NIOSH's *Respiratory Protection Manual — An Employer's Manual.*

C. Limitations — Chemical Cartridge or Canister

1. These respirators do not supply oxygen, so they must *never be worn in oxygen deficient atmospheres.*
2. They must not be used if the chemical to be protected against lacks adequate warning properties — odor, taste, or irritation, unless their use is permitted by applicable OSHA or MHSA standards. Warnings such as these are necessary to alert you that the sorbent is saturated, and the contaminant is passing through the cartridge or canister, and you are breathing contaminated air.
3. They must not be used in atmospheres immediately dangerous to life or health, except for escape.
4. They provide protection only from the specific gases or vapors they were designed to protect against (they may be worthless for other gases or vapors).

III. ATMOSPHERE SUPPLYING RESPIRATORS — SUPPLIED-AIR

A. Description — Supplied-air Respirator

Supplied-air respirators use a central source of breathing air that is delivered to the wearer through an air supply line or hose. There are essentially two major groups of supplied-air respirators — the airline device and the hose mask with or without a blower.

1. Airline Devices

The distinction of airline devices is that they use a stationary source of compressed air delivered through a high-pressure hose. Airline devices can be equipped with half- or full-face masks, helmets, or hoods, or the device can come as a complete suit. Airline respirators can be used for protection against either particulates, gases, or vapors. They provide a high degree of protection against these contaminants but they *cannot be used in atmospheres immediately dangerous to life or health* because the user is completely dependent on the integrity of the air supply hose and the air source. If something happens to either the hose or air supply, he cannot escape from the contaminated area without endangering his life.

A great advantage of the airline respirator is that it can be used for long continuous periods. There are three types of airline respirators.

a. Demand Airline Device

In a demand device, the air enters the facepiece only on "demand" of the wearer, i.e., when the person inhales. This is due to the nature of the valve and pressure regulator.

Excerpted from NIOSH's *Respiratory Protection Manual — An Employer's Manual.*

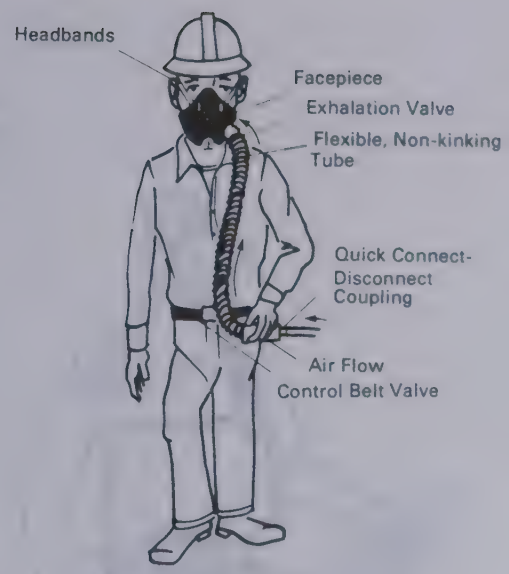
During inhalation there is a negative pressure in the mask, so if there is leakage, contaminated air may enter the mask and be breathed by the user. The leakage problem is a major drawback of the demand device. Demand devices are also available with a full-face mask, which provides a better seal than does the half-mask.

b. Pressure Demand Airline Devices

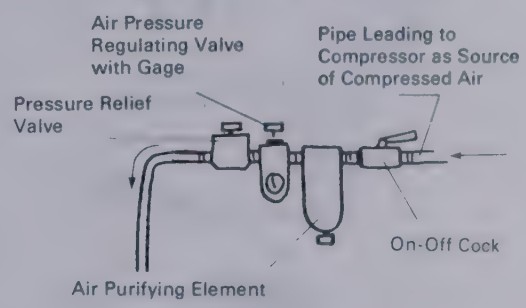
The pressure demand device has a regulator and valve design such that there is a continuous flow (until a fixed static pressure is attained) of air into the facepiece at all times, regardless of the "demand" of the user. The airflow into the mask creates a positive pressure outward. As such, there is no problem of contaminant leakage into the facepiece. This is a significant advantage of this type of device.

c. Continuous-flow Airline Device

The continuous-flow airline respirator maintains a constant airflow at all times and doesn't use a regulator, but uses an airflow control valve or orifice which regulates the flow of air. A continuous-flow full facepiece device is shown below.



The continuous-flow device creates a "positive" pressure in the facepiece, and as a result, does not have the problem of inward leakage of contaminant.



A special type of continuous-flow device that provides protection against flying particles of abrasive materials is also available. The abrasive blasting airline respirator incorporates a *loose fitting* facepiece.

d. Air Supply System

Supply air sources (compress or tanks) for the above respirator types must meet the following requirements.

i. The air compressor must be located where contaminated air cannot enter the system.

ii. The air receiver must be of sufficient capacity to enable the wearer to escape in the event of compressor failure.

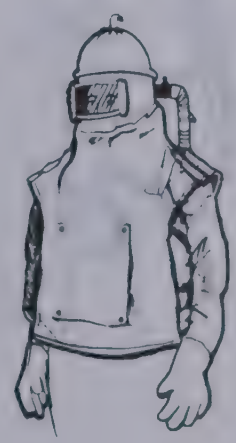
iii. Alarms indicating compressor failure and overheating must be installed into the system.

iv. If the compressor is oil-lubricated it must have a high temperature and/or carbon monoxide (CO) alarm. If there is no CO alarm, frequent carbon monoxide tests of the air must be made to insure that the CO level does not exceed 20 parts per million.

v. All airline couplings must be incompatible with outlets for other gas systems.

vi. Breathing air quality must meet the requirements of Grade D breathing air as described by the Compressed Gas Association. Grade D requirements are:

- *The oxygen content of the compressed air should be between 19.5-23.5% oxygen and the rest mainly nitrogen;*



Excerpted from NIOSH's *Respiratory Protection Manual — An Employer's Manual.*

- *Hydrocarbon concentrations must not exceed 5 parts per million;*
- *Carbon monoxide concentration must not exceed 20 parts per million;*
- *Carbon dioxide concentrations must not exceed 1000 parts per million; and*
- *There must not be any pronounced odor present.*

Air Line Continuous Flow Respirator with Full Facepiece

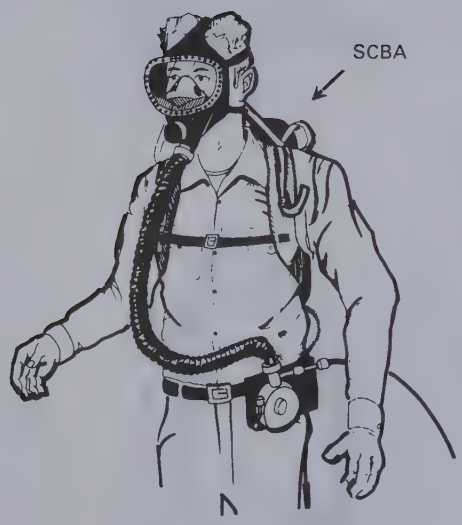
2. Hose Masks

Hose masks supply air from an uncontaminated source through a strong, large diameter hose to the facepiece, and do *not* use compressed air or have any pressure regulating devices. (An advantage of the hose mask *with* a blower is its minimal resistance to breathing.) Advantages of the hose mask *without* a blower are its theoretically long use periods and its simple construction, low bulk, easy maintenance, low initial cost, and minimal operating cost. Two types are available:

a. Those masks with hand or motor operated air blowers have a full facepiece mask. The hose length can be up to 300 feet. It must not be used at atmospheres immediately dangerous to life or health.

b. Hose masks without blowers must have a *tight fitting* full facepiece. Helmets and hoods cannot be used. The hose mask without a blower can have up to 75 feet of hose.

Limitations



1. Airline Devices

a. These devices *must not* be used in atmospheres immediately dangerous to life or health since the user is dependent upon an air hose which, if cut, crushed, or damaged, leaves him with little or no protection.

b. The trailing air supply hose of the airline respirator severely restricts the wearer's mobility. This may make the airline respirator unsuitable for those who must move frequently between widely separated work stations.

2. Hose Mask

a. The hose mask with a blower cannot be used in atmospheres immediately dangerous to life or health because the low air volume flow may result in a negative pressure being produced in the mask during inhalation allowing contaminated air to leak into the mask. Also, if the air hose is cut or obstructed, the user will be unprotected.

b. The trailing air supply hose of the hose mask severely limits mobility, so it may be unsuitable if frequent movement among separated work stations is required.

c. A severe restriction of the hose mask *without a blower* is that it is limited to a maximum hose length of 75 feet.

Excerpted from NIOSH's *Respiratory Protection Manual — An Employer's Manual.*

IV. SELF-CONTAINED BREATHING APPARATUS (SCBA)

The self-contained breathing apparatus (SCBA) allows the user to carry a respirable breathing supply with him/her, and does not need a stationary air source such as a compressor to provide breathable air. The air supply may last from 3 minutes to 4 hours depending on the nature of the device.

A. Description — SCBA

1. Closed Circuit SCBA

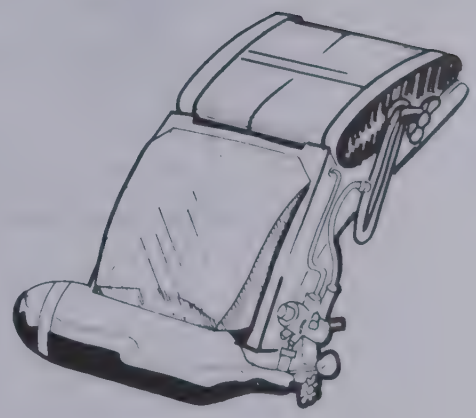
Another name for closed circuit SCBA is "rebreathing" device. The air is rebreathed after the exhaled carbon dioxide has been removed and the oxygen content restored by a compressed oxygen source or an oxygen-generating solid. These devices are designed primarily for 1-4 hour use in toxic atmospheres. Because negative pressure is created in the facepiece during inhalation, there is increased leakage potential. Therefore, the devices should be used in atmospheres immediately hazardous to life and health only when their long-term use is necessary, as in mine rescue. Two types of closed circuit SCBA are available.

a. Compressed Oxygen Cylinder Type

In this device, breathable air is supplied from an inflatable bag. Exhaled air from the wearer is filtered to remove carbon dioxide and the oxygen consumed is replenished from an oxygen cylinder.

b. Oxygen-generating Type

This type of closed circuit SCBA uses an oxygen-generating solid which, when mixed with water vapor and carbon dioxide in the exhaled breath, or when burned (a chlorate candle), releases oxygen. The oxygen then passes to the inflatable bag. This closed circuit apparatus is lighter, simpler, and cheaper than the cylinder type. However, it is useful for only about 1 hour and, once initiated, cannot be turned off.



Self-contained Breathing Apparatus (SCBA)

2. Open Circuit SCBA

An open circuit SCBA exhausts the exhaled air to the atmosphere instead of recirculating it. A tank of compressed air carried on the back supplies air via a regulator to the facepiece. Because there is no recirculation of air, the service life of the open circuit SCBA is shorter than a closed circuit system. Two types of open circuit SCBA are available, "demand" or "pressure demand."

a. Demand SCBA

In a demand SCBA, air flows into the facepiece only on "demand of the wearer," i.e., when the person inhales. This is due to the nature of the valves and pressure regulator. An example of a demand open circuit is show below. During inhalation there is a negative pressure in the mask, so if there is leakage, contaminated air can enter the mask and be breathed by the user. The leakage problem is a major drawback of the demand device. Because of this problem, a demand type open circuit SCBA should not be used in atmospheres immediately dangerous to life or health.

Excerpted from NIOSH's *Respiratory Protection Manual — An Employer's Manual.*

Oxygen-generating SCBA (closed circuit)

b. Pressure Demand SCBA

The pressure demand open circuit SCBA has a regulator and valve design which maintains a positive pressure in the facepiece at all times regardless of the "demand" of the user. As such, there is no problem of contaminant leakage into the facepiece. This is a significant advantage of the pressure demand device. A pressure demand SCBA is identical in appearance to a demand SCBA, but has a different regulator assembly and facepiece exhalation valve design.

3. Combination Atmosphere Supplying Respirator: Supplied Air and SCBA

Designed primarily as a long duration device, this respirator combines an airline respirator with an auxiliary air supply (usually compressed air) to protect against the possible failure of the primary air supply (the airline). The additional supply can be approved for 15 minutes or even longer. The choice depends upon how long it would take to escape from the toxic atmosphere if the primary air supply failed.

B. Approvals — All SCBA's

Because they provide a respirable breathing supply, all SCBA's (closed circuit, open circuit) may be used in *oxygen deficient atmospheres* as well as against *particulates, vapors, and gases.* However, *approvals* for SCBA's are based on: (1) entering into and escaping from; (2) escape only, from a hazardous atmosphere (oxygen deficient or contaminated), and (3) the work setting. If you have to use an SCBA, check the approval label to ascertain the conditions of use.

C. Limitations

1. The air supply is limited to the amount in the cylinder (SCBA's using a compressed air tank) and therefore the respirator cannot be used for extended periods without recharging or replacing the cylinders.
2. Because these respirators are bulky and heavy, they are often unsuitable for strenuous work or use in confined spaces.
3. Because of the *short* service time of the auxiliary air supply, the escape portion of the combination unit can be used only for escape from atmospheres immediately hazardous to life or health unless the escape portion has a minimum of 15 minutes service life. Such devices can then be used for entry in IDLH atmospheres provided not more than 20% of the available breathing supply is used. These devices may always be used for entry into IDLH atmospheres when utilized with the external air supply.

Excerpted from NIOSH's *Respiratory Protection Manual — An Employer's Manual.*

MEDICAL ASPECTS OF RESPIRATORY EQUIPMENT USAGE

A. GENERAL INFORMATION

So that the examining physician can render a qualified opinion regarding respirator usage by an employee, the physician, initially, should obtain from the employer the following information.

- Type of respiratory protection equipment to be used, and its modes of operation;
- The tasks that the employer will perform while wearing the respirator;
- Estimation of the energy requirements of the task (see Table 1);
- Visual and audio requirements associated with the task;
- Length of time that the user will wear the respiratory protective equipment; and
- The substance(s) to which the employee will be exposed, and the related toxicity data.

B. MEDICAL TESTS

The following medical tests might be considered by the examining physician in his/her evaluation:

- Pulmonary function test;
  —FVC
  —FEV_1
- Chest X-ray;
- Electrocardiogram;
- Blood tests;
- Eye test;
- Hearing test;
- Observation of the fit of the respirator on the employee; and
- Medical tests specific to the substance to which the employee will be exposed.

C. MEDICAL FACTORS

Some factors to be considered by the examing physician in determining the prospective user's ability to wear a respirator are:

- Emphysema — individual may be unable to breathe adequately against the additional resistance of a respirator;
- Asthma — if the user suffers an asthma attack he would be likely to remove the respirator because of being unable to breath properly;
- Chronic bronchitis;
- Heart disease;
- Anemia;
- Hemophilia;
- Poor eyesight;
- Poor hearing;
- Hernia — can be aggravated by wearing/carrying respiratory protective equipment (SCBA);

Excerpted from NIOSH's *Respiratory Protection Manual — An Employer's Manual.*

SOME SELECTED TYPES OF WORK CLASSED ACCORDING TO ESTIMATED WORKLOAD LEVEL*

Workload Level	*Energy expenditure range Kcal/hr.*
1. RESTING	**100 or less**
2. LIGHT	**101 to 200**
Sitting at ease: light hand work (writing, typing, drafting, sewing, bookkeeping); hand and arm work (small bench tools, inspecting, assembly, or sorting of light materials); arm and leg work (driving car under average conditions, operating foot switch or pedal). **Standing:** drill press (small parts); milling machine (small parts); coil taping; small armature winding; machining with light power tools; casual walking (up to 2 mph).	
3. MODERATE	**201-300**
Hand and arm work (nailing, filing); arm and leg work (off road operation of trucks, tractors, or construction equipment); arm and truck work (air hammer operation, tractor assembly, plastering, intermittent handling of moderately heavy materials, weeding, hoeing, picking fruits or vegetables); pushing or pulling light-weight carts or wheelbarrows; walking 2-3 pmh.	
4. HEAVY	**above 301**
Heavy arm and truck work; transferring heavy materials; shoveling; sledge hammer work; sawing, planning or chiseling hardwood; hand mowing, digging, ax work; climbing stairs or ramps; jogging, running walking faster than 4 mph; pushing or pulling heavily loaded hand carts or wheelbarrows; chipping castings; concrete block laying.	

*For accurate determination of a worker's energy expenditure on the job by measuring oxygen uptake of the man, refer to "Ergonomics Guide," *American Industrial Hygiene Association Journal*, 32(8): Aug. 1971, pp. 560-564.

- Lack of use of fingers or hands — respirators such as gas masks, supplied-air respirators, and self-contained breathing apparatus require connection and disconnection of parts and manipulation of valves and fittings during use. Persons with missing or disabled fingers may have difficulty in using these devices, particularly in an emergency where there is no one present to assist them; and
- Epileptic seizures.

D. EMOTIONAL/MENTAL FACTORS

Mental factors must also be taken into consideration when employees are required to wear respirators. Some individuals become claustrophobic when wearing a respirator. These individuals should not be required to wear respirators if the condition is severe enough to cause panic.

E. OTHER FACTORS

Scars, hollow temples, very prominent cheekbones, deep skin creases, and lack of teeth or dentures may cause respirator facepiece sealing problems. Dentures or missing teeth may cause problems in sealing a mouthpiece in a person's mouth. Full dentures should be retained when wearing a respirator, but partial dentures may or may not have to be removed, depending upon the possibility of swallowing them. With full lower dentures, problems in fitting quarter-masks can be expected, as the lower part of the mask tends to unseat the denture.

Excerpted from NIOSH's *Respiratory Protection Manual — An Employer's Manual.*

ERGONOMICS SYSTEMS ANALYSIS CHECKLIST

"Ergonomics" refers to the study of humans at work, with the intent of understanding the complex interaction of people with machines, tools, equipment, and work methods.

There is a growing awareness of how ergonomic factors relate to occupational illnesses and accidents. Ergonomics has brought together physiologists, anatomists, engineers, and industrial hygienists in an attempt to make the work environment more compatible with the varied capabilities of workers.

By studying the interaction of people with their work environment, it is possible to improve productivity and efficiency, and prevent acute and chronic injuries.

In order to provide the best ergonomic work environment for workers, both information stress problems and physical stress problems must be addressed. Information stress refers to the flow of information from the environment to the worker; how the worker perceives and recognizes the stimuli necessary to control a process or operate a machine or tool. Physical stress problems involve the physical capabilities, strength, and endurance of the worker.

The following checklist will help the safety manager to identify and correct ergonomic problems in the workplace, by providing an organized and thorough guide to ergonomically correct workspace, work methods, environmental load, organization of work, functional and integral load, and system output. The checklist will help the safety manager evaluate each job in terms of the demands it places on the worker.

Before beginning an evaluation of a given task or job, it is important first to get a general opinion on the major aspects of the workload and procedures involved. These questions can be helpful in this respect:

1. What is the operator expected to do and what kind of information is required to carry out the task?
2. Does the task pose an important physical load?
3. Does the task pose an important mental load?
4. Are motivation, alertness, and power of concentration strongly involved?
5. Has the work environment a significant influence on the worker?
6. Does the organization of the work have an important influence on the worker — speed, rest, pause, etc.?
7. Would it be desirable to replace the human operator, partly or entirely, by machine performance?

8. What is the learning period required for the task:
   Less than one week?
   More than one week but less than one month?
   More than one month?

9. Is the job so easy, so insignificant, or so disagreeable that the worker feels it unworthy of him or her?

These questions can help set the stage for an overall evaluation and identify the specific sections of the following checklist which most likely apply to the task or tasks being reviewed.

CHECKLIST SECTIONS

Section 1 — Workspace

Section 2 — Work Methods

Section 3 — Environmental Load

Section 4 — Organization of Work

Section 5 — Functional and Integral Load

Section 6 — System Output

ERGONOMICS SYSTEMS ANALYSIS CHECKLIST

SECTION 1 — WORKSPACE

General Questions	Yes	No	Detail Data
A — PHYSICAL DEMANDS			
1. Is the workspace sufficiently spacious?			
2. Is a favorable work posture promoted by the location of instruments, controls, work piece?			
3. Is the height of the work surface adapted to the posture? Is the height of the work surface correct in regard to viewing distance?			*1. Is the lack of workspace principally due to:* • *sharing the workspace with other workers (perhaps temporarily)?* • *distance to other machines?* • *protruding parts of the machine?* *2. If the work is done in a sitting position is there sufficient room for the legs? knees? feet?* *3. Is the unfavorable work posture due to:* • *machine?* • *work piece?* • *instruments?* • *controls?* *4. Is an altered position of the machine desirable?*
4. Are properties of the work surface correct in regard to: • hardness? • elasticity? • color? • smoothness? • other desired feature(s)?			
5. Is correct control by hands or feet promoted by the location of instruments, work pieces, or controls?			*1. Does the positioning of controls demand a static component in muscular load?* *2. Are tools and work piece located within the physiological range of movement?* *3. Are the controls located within easy reach in regard to work posture?* *4. Are the grips correctly positioned in regard to required forces and movements (location, direction)?* *5. Does the positioning of instruments, work piece, and controls correspond with sequence and frequency of required actions?*
6. Is foot control by means of pedals necessary or desirable?			*1. Is the location, size and construction of pedal(s) correct?* *2. Have pedals been avoided in standing work and limited to two in sitting work?* *3. In standing work, if the use of pedals is imperative, must the worker stand almost continuously on one and the same leg or is alternating use of left or right foot possible?* *4. Can the pedals be used while sitting, and can the feet be alternated?* *5. If the work is done in a sitting position, is a variation in posture hampered by use of one or more pedals?* *6. Does the type of pedal used correspond with required force, range, and rate of movement?* *7. Is the counterpressure of the pedal(s) correct?*

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ERGONOMICS SYSTEMS ANALYSIS CHECKLIST

SECTION 1 — WORKSPACE

General Questions	Yes	No	Detail Data
7. Is foot control by means of push button(s) necessary or desirable?			*1. Is the counterpressure of push button(s) correctly chosen?* *2. Can the button be pushed down by the toe instead of the heel?*
8. Is finger control by means of push buttons necessary or desirable?			*1. Is surface of the button large enough to have contact with the whole fingertip?* *Is surface concave to fit fingertip?* *Is surface too smooth?* *2. Is counterpressure low enough in regard to frequent use (errors) and high enough when the button is used as a starter (danger)?*
9. Is shape, size, surface, and material of hand controls correct in regard to required forces?			
10. Are the required forces acceptable?			*1. Can the degree of loading be decreased by:* • *decreasing weight of objects being handled?* • *use of counter weights?* • *use of electric, hydraulic, or pneumatic devices?* • *conveyors?* • *cranes, pulleys?* *2. Can the degree of loading be decreased by:* • *changing direction of forces?* • *use of stronger muscle groups?* • *limiting time of muscle contraction?* *3. Are jigs used as much as possible?* *4. Are moving work pieces correctly conveyed and stopped (use of gravitation, chutes, etc.)?* *5. Is movement and force required for handling controls acceptable?* *6. When force is required, is control located so that it can be applied without undue strain or need to maintain static load?*
11. Are chairs and supports available to lessen unnecessary standing?			*1. Is the chair or support correct in regard to:* • *dimensions of worker(s)?* • *upholstering?* • *back rest?* • *work height?* • *adjustability?* • *ease of standing up?* • *variation in work posture?* *2. Is a horizontally or vertically adjustable chair required?* *3. Is use of a one-legged stool desirable?*
12. Is a foot rest necessary?			*1. Is a proper foot rest available?* *2. Is there sufficient room for a foot rest?* *3. Is the foot rest correct in regard to:* • *position?* • *size?* • *inclination?* • *surface?*

ERGONOMICS SYSTEMS ANALYSIS CHECKLIST

SECTION 1 — WORKSPACE

General Questions	Yes	No	Detail Data
13. Is support for elbows, forearms, hand, or back necessary?			*1. Is the support(s) correct in regard to:* • *position?* • *size?* • *movability and adjustability?* • *surface?*
14. Is the floor of the workspace correct?			*1. Is the floor correct in regard to:* • *friction between floor and supports, soles, tools, products?* • *horizontal level?* • *evenness?* • *thermal conductivity?* • *hardness, elasticity?*
15. Are hand tools used?			*1. Is weight of tool correct? too heavy? too light?* *2. Is hand grip correct in dimension and shape?* *3. Does the hand tool used for fine manual work provide sufficient contact surface with hand?* *4. Is operational part of tool correct in dimension and shape?* *5. Is length of shaft correct in regard to work posture and performance?* *6. Does shaft have correct elasticity?* *7. Is surface of tool correct in regard to:* • *friction between hand and grip?* • *thermal conductivity?* *8. If possible, have different tools been combined into a single tool?* *9. Is length of tool correct in regard to fine, manual work in order to avoid or diminish effects of tremor?* *10. Is there a planned location for the tool(s)?*
16. Are containers (tote boxes, carton, etc.) used, appropriate in regard to: • weight? • dimensions? • locations? • safety?			
17. Can machine speed be adjusted to the skill of worker (performer)?			
18. Has variability of performance time been taken into account?			
19. Does machine construction allow for effective maintenance and repair? • accessibility? • lighting? • tracing of technical troubles? • safety guarding against risk or accidents?			
20. Is there any risk of burns?			
21. Are any parts of the body exposed to undue constant or intermittent mechanical pressure?			

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ERGONOMICS SYSTEMS ANALYSIS CHECKLIST

SECTION 1 — WORKSPACE

General Questions	Yes	No	Detail Data
22. Does the work require use of personal protective devices? • clothing? • shoes? • gloves? • eye protection? • face protection?			*1. Does the protective device(s) impede communication (hearing/speaking)?* *2. Does the protective device(s) impede actions and movements?*
23. Does the machine cause significant vibration?			*1. Does vibration perceptibly affect the body?* *2. Does vibration perceptibly affect performance?* *3. Is there inconvenience caused by continuous or intermittent vibration?*

B — MENTAL DEMANDS

1. Visual System

24. Does the work imply high visual demands?			
25. Does the work require a high level of illumination?			
26. Is general artificial illumination necessary?			
27. Is local illumination necessary?			
28. Does the work layout imply exposure to different levels of illumination?			
29. Is visual data easy to discriminate in regard to variable daylight, reflection, etc.?			*1. Is illumination level in regard to visual demands:* • *in daylight: good, sufficient? poor?* • *in artificial light: good? sufficient? poor?* *2. Does artificial illumination produce undue flickering and/or stroboscopic effects?*
30. Is there a great, medium, or negligible difference in brightness (contrast) between the object and its surroundings?			*1. Is contrast discrimination of instruments, machine, or work piece adequate in regard to:* • *color?* • *surface?* • *localization?* *2. Is difference in brightness in daylight or in artificial lighting:* • *small?* • *medium?* • *great?*
31. Is there glare from workspace or surroundings?			*1. Is glare caused by:* • *unprotected sources of light?* • *reflecting surfaces?* • *reflecting machine parts?* • *windows?* • *other sources?*

ERGONOMICS SYSTEMS ANALYSIS CHECKLIST

SECTION 1 — WORKSPACE

General Questions	Yes	No	Detail Data
32. Are there special requirements in regard to color perception?			*1. Are the colors in daylight and in artficial lighting adequate and appropriate in regard to:* • *nature of work?* • *desirable contrast?* • *warnings/signaling of danger?* • *color of light source?*
33. Are the objects to be distinguished: • very fine? • fine? • coarse?			
34. Do the objects to be distinguished: • move? • move slowly? • move rapidly?			
35. Does the location of instruments, work pieces, controls, etc., aid good vision?			
36. Does the location of instruments, work pieces, controls, etc., restrict necessary accommodations?			
37. Are controls located in front of worker within the optimal visual area and reach?			
38. Are warning lights attention-getting and are they positioned in the central part of visual field?			
39. Is it possible for the operator to see the surroundings of the work piece?			
40. Is the distance adequate for good vision?			
41. Is binocular vision essential?			
42. Is use of optical aids required?			*1. Are optical aids adequate in regard to:* • *visual field?* • *size?* • *focus?* • *enlargement?*

B — MENTAL DEMANDS

2. Auditory System

43. Does the work impose high auditory demands? • What are the types of auditory signals?			
44. Does the task require verbal communication?			
45. Is normal communication impeded by noise level at the workspace?			
46. Can auditory signals easily be distinguished from normal noise of the workspace environment?			
47. Does the task require a reduced noise level?			
48. Can auditory signals with different meanings be easily distinguished from each other?			

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ERGONOMICS SYSTEMS ANALYSIS CHECKLIST

SECTION 1 — WORKSPACE

General Questions	Yes	No	Detail Data
49. Do the auditory signals have the right physical qualities?			*1. Can auditory signals be distinguished from each other by difference in:* • *duration?* • *frequency?* • *sound level?* • *pattern?*

B — MENTAL DEMANDS

3. Other Senses

50. Does the work imply high tactile demands?			
51. Can different parts, control knobs, and tools easily be recognized by touch?			
52. Can parts, control knobs, and tools be recognized by their position?			
53. Does the work imply high demands of equilibrium?			
54. Does the work involve position movements or precise force application (proprioception)?			
55. Does the work imply high demands of smell?			

B — MENTAL DEMANDS

4. Dials and Displays

56. Are dials, panels, or displays in use?			
57. Are the instruments legible?			
58. Can each measuring instrument be located easily?			
59. Can measuring instruments easily be distinguished from each other?			*1. LEGIBILITY* *a. Can desired data quickly be obtained from dials with accuracy?* *b. Is scale correctly graduated and simple as possible?* *c. Do letters, numbers, and markings conform to relevant standard in relation to required reading distance?* *d. Is pointer simple and clear? Does it allow numbers to be read without obstruction?* *e. Is pointer mounted so visual parallax is minimized?* *f. Have great differences in brightness between panels, dials, and surroundings been avoided?* *g. Is legibility of dials impaired by light reflections?* *h. Has glare from displays been avoided?* *i. Has shadowing by pointers, edges, or controls been avoided?* *j. Is reading distance limited to ± 70 cm if control knobs have to be handled while reading dials?* *k. Does the chosen numerical progression on dial(s) minimize reading errors?*

ERGONOMICS SYSTEMS ANALYSIS CHECKLIST

SECTION 1 — WORKSPACE

General Questions	Yes	No	Detail Data
			2. *GROUPING*
			a. *Is it possible to group different categories of dials in different planes of mounting?*
			b. *Can groups of dials of a specific category be divided by area or color patterns?*
			c. *Are the divisions of scales on dials identical as far as possible?*
			d. *Is dial located near corresponding control(s)?*
			e. *Are the most important and/or most frequently used instrument(s) given best position in the normal visual field?*
			f. *Are most frequently used instruments grouped together in one area of visual field?*
			3. *POSITIONING*
			a. *Is positioning of controls on similar machines or panels correctly standardized?*
			b. *Can instruments be read without undue movement of head and/or body?*
			c. *Is the display and size of panel correct in regard to sitting posture, reach, and viewing direction?*
			4. *ACCURACY AND SPEED*
			a. *Is accuracy of instrument compatible with required reading accuracy?*
			b. *Is instrument designed to minimize reading errors?*
			c. *Is time lag between changes in system and its indication on dial(s) minimized as far as possible?*
			d. *Are digital type (direct reading) dials used for accurate reading and for adjusting to a predetermined value?*
			e. *Is a moving pointer used for estimation of the degree of deviation and for adjusting deviations?*
			f. *Is the dial as simple as possible in regard to desired information?*
			g. *Can color zones be used instead of numbers and markings when only information checking is required?*
			h. *Is an attention-getting signal used to indicate breakdown of a measuring instrument?*
			5. *CONFORMITY*
			a. *Does dial grouping conform to desired reading sequence?*
			b. *Do all pointers, in their correct working position, point in the same direction (horizontal or vertical)?*
			c. *Is positioning of dials in different panels the same if the panels serve a similar purpose?*

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ERGONOMICS SYSTEMS ANALYSIS CHECKLIST

SECTION 1 — WORKSPACE

General Questions	Yes	No	Detail Data
			6. CONTROLS *a. Is it possible to avoid positions of rotating control switches differing by 180 degrees?* *b. Is it possible to immediately see which situation is indicated by position(s) of control(s) (e.g., on-off)?* *c. Does controlling hand impede reading of dial(s)?* *d. Is it possible to indicate zero position by a stop?* *e. Is it possible to promote recognition of controls by means of differences in shape, color, size?*

SECTION 2 — WORK METHODS

A — PHYSICAL DEMANDS

60. Does the work imply a large muscular load?			
61. Are large or small muscles or muscle groups involved?			
62. Does the work imply an insignificant muscular load?			*1. If the muscular load is very low, are additional tasks possible?*
63. Is the work done sitting, standing upright, walking, or in a combination of posture and activity?			
64. Does the work imply peak loads? • what is the frequency and duration? • is the working posture correct? • can the degree, duration, or rate of load be reduced by means of technical measures?			
65. Do loads have to be lifted and carried?			*1. If loads have to be lifted and carried —* • *what are their normal weights?* • *are they carried on the shoulders?* • *are they carried on the arms?* • *are they lifted from floor level?* • *can they be lifted in the correct posture?* • *are passageways free of obstacles?*
66. Is muscular load predominantly dynamic or static?			
67. Is the muscular load predominantly on: • the arms? • the legs? • the neck? • the trunk? • small muscles of hand, fingers?			
68. Are small and/or large groups of muscles subject to static exertion induced by holding of material or tools?			
69. Are large groups of muscles subject to static exertion induced by work posture?			
70. Is the work posture such that the muscles take the load correctly?			
71. Is variation in work posture possible?			

ERGONOMICS SYSTEMS ANALYSIS CHECKLIST

SECTION 2 — WORK METHODS

General Questions	Yes	No	Detail Data
72. Does the work procedure provide for reasonable alternating of work and rest and of static and dynamic elements in regard to muscular load?			
73. Do secondary activities inherent in the work methods provide for changes in muscular loading?			
74. Is the pattern of movement correct?			*1. Is there sufficient possibility for movement?* *2. Does the usual pattern of performance include superfluous movements?* *3. Is simplification of movements possible and desirable?* *4. Are the movements symmetrical?* *5. Are the movements rythmical?* *6. Are left and right limbs (arm, leg, foot) used alternatingly, if necessary, when symmetrical movements are not acceptable?* *7. Are the directions, location, and length of movements correct in regard to:* • *required force?* • *required accuracy?* • *required time?* • *prevention of static muscular exertion?* • *compatibility?* *8. Are joint movements within acceptable limits?* *9. Can controlled movements be replaced by free (ballistic) movements?* *10. Can simultaneous left and right hand movement be promoted by:* • *location of information sources?* • *location of controls* *11. Can abrupt changes in direction of movement be avoided?* *12. Is kinetic energy correctly used?* *13. Can loss of kinetic energy be avoided?* *14. Do imposed subsequent actions fit into the one pattern of movement?* *15. Do the actions consist of precisely controlled movements?* *16. Is it desirable and possible to make the pattern of movement less variable?* *17. Is there any combination of precise movement and great muscular exertion?*
75. Does the control of movement require much muscular exertion?			*1. Has the number of active muscular groups been restricted by means of a support?* *2. Is sequence of active muscular contractions correct?*

ERGONOMICS SYSTEMS ANALYSIS CHECKLIST

SECTION 2 — WORK METHODS

General Questions	Yes	No	Detail Data
76. Can undesirable displacement of center of gravity and rotation of the body be avoided?			
77. Have the exact patterns of movement been prescribed?			

B — MENTAL DEMANDS

78. Is the relationship between direction of control movement and the effect compatible?			*1. Do the control movements always have the following corresponding effects?* *a. FORWARD = on, advance, more, +* *b. TO THE LEFT = off, to the left, less, −* *c. BACKWARD = off, backward, less, −* *d. TO THE RIGHT = on, to the right, more, +* *2. Is the position of information providing instruments compatible with the position of corresponding knobs and handles?*
79. Does the work imply high demands on accuracy of movements?			*1. When accuracy is required, does the control allow for accurate movement?* *2. Are tools correct in regard to accuracy of movement?*
80. Does data have to be processed before required action can be taken?			
81. Is the use of tables (lists, etc.) required, and is this efficient?			
82. Does different data have to be compared before action can be taken?			
83. Is the action to be taken rigidly prescribed, or should it be improvised?			
84. Does data have to be estimated?			
85. Are standards of comparison (control norms) actually present and regularly used?			
86. Are parts to be assembled supplied in a correctly pre-adjusted way?			*1. Can pre-adjusting, aiming and assembling be performed quickly and correctly by tactile sense?*
87. Can signals easily be confounded?			*1. Can confusion of signals have serious consequence?*
88. Can accessories, objects easily be confounded?			*1. Can confusion of these parts have serious consequences?*
89. Can movements easily be confounded?			*1. Can confusion of movements have serious consequences?*
90. Do signals always have the same meaning?			

ERGONOMICS SYSTEMS ANALYSIS CHECKLIST

SECTION 2 — WORK METHODS

General Questions	Yes	No	Detail Data
91. Are controls positioned in sequence of task performance?			
92. Can controls easily be recognized by shape, size, labeling, color, for normal use and for emergency?			
93. Are controls located as near as possible to the corresponding sources of information?			
94. Does the worker use unofficial signals?			*1. Are these unofficial signals as reliable, or perhaps more reliable, or are they preferred because they are easier to perceive?* *2. If easier but less reliable signals are preferred, does it mean that the official signals should be improved?*
95. Do the workers receive the necessary information (qualitative and quantitative) regarding process flow and output (production) at sufficient short notice?			
96. Is there any possibility for pauses in monitoring tasks?			
97. Is the task adapted to the capacities of older workers in regard to: • pacing? • visual demands? • short-term (transitory) memory?			

C — MENTAL DEMANDS; FLOW OF INFORMATION

98. Is the data required to carry out the task obvious, unequivocal, and to the point?			
99. Is all this data necessary for performance?			
100. Is the rate of information likely to exceed the mental capacity of the operator and overload him?			
101. If any of the sensory channels is likely to be overloaded, can the load be more evenly spread?			
102. Is the rate of information likely to underload the operator?			*1. Do signals have to be detected when the worker's mind is occupied by monitoring actions?* *2. Do displays of different information differ in more than one aspect?* *3. Is the method of displaying information too detailed?* *4. Is received information to be retained for longer than a few seconds?* *5. Is the duration of an important signal not shorter than one second?* *Are the signals repeated?* *Do they appeal to different senses?* *6. Is the attention span longer than about 20 minutes. If a signal can occur at any time, does it occur less than 4 times per half hour?* *7. Is reduction possible in the number of signals per unit, the number of signals per source, and the number of sources?*

ERGONOMICS SYSTEMS ANALYSIS CHECKLIST

SECTION 2 — WORK METHODS

General Questions	Yes	No	Detail Data
103. Is the correct sense to be used in regard to the meaning of the signal? • danger, alarm — ear; • normal machine performance — eye; • discrimination of controls, etc. — tactile senses.			*1. Are urgent signals given through the auditory sense?* *2. Is it desirable that visual signals be replaced by other signals?* *3. Do signals have the usual meaning (e.g. red for danger)?*
104. Is it possible that signals of different sources occur simultaneously?			*1. If this can happen, is there any preference to be given?*
105. Do the signals to which preference has to be given have the highest attention-getting value?			*1. Does critical information have an attention-getting value of its own?* *2. Are there any rare signals carrying information? Do these have more than usual attention-getting value?* *3. Does information which has to be taken at one glance consist of more than five different items?*
106. Do identical or similar signals occur for a long time and are they frequently repeated?			
107. Are different answers possible to one and the same signal, whereas only one is the most suitable?			*1. Can the worker be immediately aware of the effects of a wrong choice?* *2. Are the effects of a wrong choice important?*
108. Are all factors relevent to a decision presented at the right time and in the right sequence?			*1. Are any misleading or ambiguous factors presented which might cause errors?*
109. Is adequate time allowed in machine or process cycle for decisions and resulting action?			
110. Can rapid feed-back of the effects of adjustment to system be given?			

SECTION 3 — ENVIRONMENTAL LOAD

A — CLIMATE

111. Are climatic conditions within an acceptable comfort zone?			
112. If climatic conditions are not within the comfort zone, is this due to: • air temperature? • humidity? • air movement? • radiation?			*1. Is the work performed in extreme temperature(s) (high or low)?* *2. If the work is not performed within the comfort zone, are the work periods and rest pauses adapted to heat or cold?*

ERGONOMICS SYSTEMS ANALYSIS CHECKLIST

SECTION 3 — ENVIRONMENTAL LOAD

General Questions	Yes	No	Detail Data
			3. Does the room or facilities heating provide a more or less homogenous air temperature in the work environment?
			4. What is the general range of air temperature in the department: • *in summer?* • *in winter?*
			5. What is the general range of relative humidity in the department: • *in summer?* • *in winter?*
			6. If there is any energy radiation, to or from the worker, does it produce any uncomfortable or excessive warmth or cold?
			7. Is the workplace near cold or hot surfaces?
			8. If there is any undue cooling effect caused by air movement, is this excessive or uncomfortable?
			9. Are preventive measures taken against uncomfortable climatic conditions?
			10. Do these preventive measures impede performance?
113. Is the employee during his or her daily work exposed to rapid changes in climatic conditions?			*1. Is the rapid change caused by the work process?* *2. Does the rapid change occur because the worker has to change location?*

B — NOISE

114. Does noise in the work environment cause inconvenience to workers and/or interfere with worker performance?			
115. Is there risk of hearing loss due to noise?			*1. What is the level and quality (frequency spectrum) of the noise?* *2. Is there a predominant pitch or does the pitch fluctuate?* *3. Is the noise intensity and quality constant or changing?* *4. Is the source of the noise* • *outside the work facility?* • *in the facility?* • *in adjoining department(s)?* • *in the department itself?* *5. Is the noise produced by the handling of materials and tools, or by machines?* *6. Is isolating or sound absorbing material adequately used?*

ERGONOMICS SYSTEMS ANALYSIS CHECKLIST

SECTION 3 — ENVIRONMENTAL LOAD

General Questions	Yes	No	Detail Data
			7. Have the sources of noise been adequately isolated? *8. Have adequate preventive technical measures been taken to control the source?* *9. Have the noisiest machines been located as far as possible from the workers?*
C — RADIATING ENERGY			
116. Does the work method imply the emission of other radiating energies which can be harmful or cause inconvenience to the worker (U.V., ionizing radiation, etc.)?			
D — CHEMICAL RISKS			
117. Does the work method imply exposure to chemical agents and/or dust?			*1. Do chemical agents and/or dust cause inconvenience or health risks to the worker?* *2. Is the use of technical preventive measures against chemical agents or dust necessary?*
E — PERSONAL PROTECTION			
118. Is the use of personal protective devices necessary because of the environmental load?			
SECTION 4 — ORGANIZATION OF WORK			
119. Is the work performed in shifts?			*1. What is the organization of the shifts:* • *a two shift system?* • *a three shift system?* • *a four shift system?* • *changing time of shifts?*
120. What are the official working times: • per day? • per week?			
121. What is the average overtime in hours: • per day? • per week?			
122. Are definite work pauses included in the work itself?			*1. How long are the definite pauses?* *2. How are these pauses distributed over the working period?* *3. Does work method allow the operator spontaneous pauses?*

ERGONOMICS SYSTEMS ANALYSIS CHECKLIST

SECTION 4 — ORGANIZATION OF WORK

General Questions	Yes	No	Detail Data
123. Is the work rigidly paced?			*1. Have variations in working speed been taken into account in organization of the work?* *2. Is the working speed free or is the worker paced:* • *by the speed of the machine?* • *by the wage system to maintain a certain speed?* *3. Is rigid pacing of operatives by machines or belts essential or can it be avoided by introduction of buffers or queues?* *4. When pacing systems are used, is the speed of the machine regulated to:* • *the paced performance of the operatives as distinct from the unpaced performance?* • *the natural variability of the operatives as distinct from the levelled performance?* *5. Are operatives selected in terms of variability as well as speed of performance?* *6. Are the operatives matched by these criteria on production lines when operatives pace each other?* *7. Are adequate buffers allowed in the production line between operatives?* *8. Is the maximum tolerance — "feeding" time as a proportion of operation cycle time — allowed?*
124. To what extent can the load be decreased by modifying work layouts and job discription?			

SECTION 5 — FUNCTIONAL AND INTEGRAL (TOTAL) LOAD

125. Is the work physically • light? • moderately heavy? • very heavy?			*1. In continuing work is the pulse rate per minute during working hours, on the average:* • *90?* • *90 to 110?* • *110 to 130?* • *130?* *2. In continuous work is the respiratory rate per minute during working hours, on the average:* • *15?* • *15 to 30?* • *30?* *3. What is the estimated total energy expenditure per 24 hours?* *4. In continuous work is the estimated energy expenditure, in Kcal per minute, during working hours on the average (basal metabolic rate included):* • *3?* • *3 to 5?* • *5?* *5. In discontinuous work (peak load) determine pulse rate within 15 seconds after the peak:* *6. Does pulse rate recover completely between peak loads?*

ERGONOMICS SYSTEMS ANALYSIS CHECKLIST

SECTION 5 — FUNCTIONAL AND INTEGRAL (TOTAL) LOAD

General Questions	Yes	No	Detail Data
126. Does the work cause continuous visible sweating?			
127. Can considerable rise in body temperature be expected during working hours?			
128. Is there any reason to expect either short term or long term effects on well-being and health of the worker(s)?			*1. Evaluate the number and reasons of transfers or dismissals.* *2. Evaluate occupational health data:* • *symptoms and signs* • *medical transfers* • *sick leave absence*
129. Is the work suitable for: • men? • women? • young workers? • older workers? • the physical and/or mental load?			
130. Try to evaluate each of the areas covered in the several sections — physical and mental load of work space, work method, environmental load, and organization load, in three classes: light, medium, and heavy across the corresponding squares:			

LOAD (√)	WORK SPACE		WORK METHOD		ENVIRONMENTAL		ORGANIZATIONAL	
	PHYSICAL	MENTAL	PHYSICAL	MENTAL	PHYSICAL	MENTAL	PHYSICAL	MENTAL
LIGHT								
MEDIUM								
HEAVY								

131. Does a combination of physical and mental load impede performance either by asking for simultaneous action or causing too much combined stress?			

ERGONOMICS SYSTEMS ANALYSIS CHECKLIST

SECTION 6 — SYSTEM OUTPUT

General Questions	Yes	No	Detail Data
132. Is an analysis of performance or production errors available?			*1. Does the analysis show:* • *operator's errors?* • *non-conforming product?* • *tool wastage?* *2. Is it possible that the error or errors resulted as a function of the time of day or rate of performance?* *3. Does the analysis provide clues with respect to the effectiveness of:* • *measuring instruments?* • *controls?* • *maintenance procedures?* • *lighting?* • *feedback of results?* • *learning/training methods?*
133. Is a change in output criteria desirable?			*1. Is alteration of product design or output standards desirable in view of:* • *required accuracy of movement?* • *forces to be exercised?* • *accessibility?* *2. Should the change be made in:* • *production?* • *transportation?* • *maintenance?*

Next page is 5-75

HOW TO DEVELOP A WRITTEN HAZARD COMMUNICATION PROGRAM

The Hazard Communication Standard, 1910.1200, requires employers to inform employees of the chemical hazards to which they are or may be exposed in the workplace. Under the standard, employers must develop a written hazard communication program detailing the methods the employer plans to use to meet the standard's requirements. The written program must include all the elements required by the hazard communication standard which apply to the employer's operations, and must be made available to employees.

Any written program is best when it is concise and organized for quick reference. A good way to begin the written program is to start with a list of program components (this can also serve as a contents guide to subject and page location in the written plan). To help start your written plan, consider the following:

(Company or organization name)
HAZARD COMMUNICATION PROGRAM
Prepared (date)
by _____
Title/Position

This program guideline has been prepared to comply with requirements of the Federal OSHA Standard 1910.1200 (e), and to ensure that information related to use, handling and storage of hazardous chemicals is provided to and made available to all employees who may be affected by exposure to the specific chemical(s). The written plan includes guidelines on identification of chemical hazards and the preparation and proper use of container labels, placards and other types of warning devices.

HAZARD COMMUNICATION PROGRAM CONTENTS GUIDE

A. Chemical inventory .....
B. Purchasing procedures .....
C. Labeling and placards .....
D. Material safety data sheets (MSDSs) .....
E. Employee information/training guide .....
F. Employee training schedule .....
G. Job/process safety analysis .....
H. Hazards of non-routine tasks .....
I. Informing outside contractors .....

A. CHEMICAL INVENTORY

Inventory records of workplace chemicals must be maintained, either for the overall facility or for individual or work areas. These records must be kept current.

The format for the inventory record can be that of an inventory log with provisions to show usage (depletion) and additions as new stock is acquired.

The record should show:

- chemical name(s);
- quantity on hand;
- quantity withdrawn (used) or added;
- type and size of container(s);
- where in the workplace the chemical may be found;
- storage requirements/quantity limitations/precautions;
- material safety data sheet number;
- source from which purchased or obtained;
- by whom ordered; and
- date of record entry.

[NOTE: Take note of any local regulations relating to hazardous materials recordkeeping requirements. It may be possible to utilize a similar records form for your chemical inventory.]

B. PURCHASING PROCEDURES

The company should require that purchase orders for chemical materials contain a provision, or be accompanied by a written request to the vendor or supplier that:

1. material safety data sheet(s) be provided; and
2. container(s) bear required identification and warning labels.

[NOTE: In the purchase order procedure, you may want to develop a means by which to notify in advance the receiving, warehousing, and storage departments of any special precautions for handling the material when it arrives.]

C. LABELING AND USE OF PLACARDS

Department supervisors (or other designated individuals — by title or name of individual) are responsible for labeling of chemical containers.

The designated individual(s) are to ensure that containers coming from manufacturers, importers, or distributors have the correct, required labels. These labels are not to be removed or defaced unless they will be replaced immediately with in-house labels.

Each container must be labeled, tagged, or marked with the identity of the hazardous chemical it contains, and must show hazard warnings appropriate for employee protection. The label must include:

1. name of chemical, and synonyms if any;

2. signal word: CAUTION, DANGER, WARNING;
3. statement of hazard;
4. necessary precautions; and
5. first aid procedures.

[NOTE: The information on the label must agree with that contained in the material safety data sheet for the chemical. A corresponding identification number or letter should be used on both the label and the MSDS. The purpose is to provide a means for quicker access to the MSDS should an emergency arise.]

Labels must be legible, in English (indicate if an additional language is needed for your work force) easily understood by employees, and prominently displayed.

NOTE: There are certain exemptions to in-plant labeling requirements for individual containers:

1. Placards or signs may be posted which convey the hazard information if there are a number of stationary containers within a work area which have similar content and hazards.
2. Standard operating procedures, process sheets, batch tickets, blend tickets, and similar written materials can be substituted for container labels on stationary processing equipment as long as they contain the same information as the container labels and are readily available to employees in the work area.
3. Labels may not be required on portable containers into which chemicals are transferred from labeled containers, when the portable container is intended only for the immediate use of the employee who makes the transfer.
4. Pipes or piping systems may not require labeling (however, you may want to consider the desirability for labels at your facility.)
5. Pesticides; foods, food additives, colorings, drugs, or cosmetics; beverage alcohols; and consumer products whose labels are controlled by other federal agencies and laws do not require duplicative labeling.

D. MATERIAL SAFETY DATA SHEETS

Material safety data sheets must be maintained in current status and readily accessible during each workshift to employees for reference at each affected work area. All employees who are expected to work with, or be exposed to chemicals are to be made aware of the location of the MSDSs and of the information these sheets provide.

Supervisors are to ensure that the MSDS are kept current and include:

1. identity of chemical, common names and synonyms;
2. information on physical and chemical characteristics of the chemical (such as vapor pressure and flash point; potential for fire, explosion, and reactivity);

3. known acute and chronic health effects, physical and/or health hazards, routes of entry;
4. information on exposure limits and whether OSHA, the International Agency for Research on Cancer or the National Toxicology Program consider the chemical a carcinogen;
5. precautionary measures for safe handling;
6. emergency and first aid procedures;
7. date of preparation and/or date of latest entry or update; and
8. identification of the party responsible for the MSDS by name, address, and telephone number.

All spaces on every MSDS must be complete. Any category for which no relevant information was found must show that no applicable information was found.

[Note: As noted on page Z-110, item 1910.1200 g.9 (a) and (b), MSDSs may be kept in any effective form that will ensure the required information is provided for each hazardous chemical, and is accessible during each workshift. In fact, you may use operating procedures and/or a means designed to cover groups of hazardous chemicals where it is more appropriate to address the hazards of an entire process rather than of individual chemicals.]

E. EMPLOYEE INFORMATION AND TRAINING

Supervisors must ensure that all employees in their department or work area who handle or may be exposed to hazardous chemicals are made aware of this written program, and that it is available for their review. Employees are to be informed of:

1. chemicals kept in and used in the work area; and
2. material safety data sheets for the chemicals.

Supervisors must ensure that all affected employees in their department or work area receive training on the hazardous chemicals found in their work area both at time of initial assignment and whenever a new hazard is introduced into the work area, or when they are shifted to a new area where different substances are used. (An annual schedule for retraining should be developed.)

The training program must include:

(a) method(s) that may be used to detect release of hazardous chemical in the work area. Where applicable the employee is to be informed of:
   - monitoring procedures being conducted;
   - continuing monitoring devices;
   - visual appearance of the chemical when released;
   - odor associated with the chemical;

(b) physical and health hazards of the chemical(s);

(c) protective measures which can be taken;

(d) specific procedures being implemented to protect employees from exposure to the hazardous chemicals:

- work practices
- emergency procedures
- use of and availability of personal protective devices;

(e) details of the hazard communication standard and written program, including:

- explanation of the labeling system.
- explanation of the material safety data sheets.
- how the employee can obtain and use the approriate hazard information.

It is suggested you include in the written program samples of both a label and a material safety data sheet.

F. EMPLOYEE TRAINING SCHEDULE*

Supervisors and department heads must prepare a schedule of information sessions and training for all affected employees in their area or department. The schedule must document the dates of the information or training session(s) and the subject material covered. (See training schedule forms.)

Each employee should sign-off on the appropriate training program or informational session statement (see sample form), and/or initial the training schedule log.

G. JOB PROCESS/JOB SAFETY ANALYSIS*

The job safety analysis procedure described in Volume 2 of the OSHA Reference Manual, beginning on page 5-14a lends itself ideally to the task of informing and training employees in actual on-the-job processes and operations. We suggest use of this procedure to meet the requirements of this hazard communication standard. Since it is relatively easy to reproduce copies of the JSAs as needed, the copies can be used as one means by which to provide each affected employee with a detailed, written plan containing the identity of the chemicals used on-the-job, the hazards identified, the precautions to be taken, and the personal protective devices required to be used.

H. HAZARDS OF NON-ROUTINE TASKS

Supervisors must inform employees in their work areas of any special task that may arise which would involve possible exposure to hazardous chemicals. In such instances, the supervisor must ensure that the affected workers are familiar with, and know how to interpret and use the information on the chemical labels and the appropriate, applicable material safety data sheets. The written hazard communication program must outline the methods by which the employees will be informed of these hazards.

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* These guidelines are implied but not specifically required by the hazard communication standard.

HAZARD COMMUNICATION EMPLOYEE INFORMATION AND TRAINING SCHEDULE/LOG

Department ______________________ Manager/Supervisor ______________________

(Enter date(s) education/training sessions are scheduled for or attended.)

EMPLOYEE NUMBER	EMPLOYEE NAME	GENERAL INFO. HAZARD COMM. STANDARD	HAZARD RECOGNITION	LABELING AND MSDS	PERSONAL PROTECTION	SAFE OPERATION PROCEDURES	EMERGENCY PROCEDURES	*(Other topics or comments — divide as needed)*

HAZARD COMMUNICATION INFORMATION/TRAINING SCHEDULE

TOPIC	INSTRUCTOR	DATE AND TIME	LOCATION

SAMPLE SIGN-OFF STATEMENT

I have received information on the Hazard Communication Standard 29 CFR 1910.1200, and understand how to interpret and to use the labeling systems and Material Safety Data Sheets (MSDSs) that are in use and accessible to me in my work area. I agree to observe and follow the safe work practices as presented to me in the training sessions I attended on _____,
at _____.

_____ _____
Employee Signature Date

The above named employee has been informed and instructed by _____ on safe work practices, chemical hazard recognition, interpretation and use of chemical labels, MSDSs, the CFR 29, 1910.1200 (e) Standard, and the location at which these items are accessible to the employee.

_____ _____
Supervisor or Foreman Date

SAMPLE SIGN-OFF STATEMENT (SPANISH)

Yo he recebido informacion sobre Comunicacion de Peligros Estandarte 29 CFR 1910.1200, y comprendo como usar y interpretar los systemas de marqueo junto con las Hojas de Datos sobre Seguridad (MSDS), que se encuentran en uso y accessible en me area de trabajo. Yo estoy de acuerdo a observar y seguir las practicas seguras presentadas a mi en la sesion de entrenamieno attendida este dia, _____,
en _____.

_____ _____
Firma de Empleado Fecha

El empleado nombrado anterior, a sido informado y instruido por _____ en las practicas seguras, a reconozer peligros de quimicas, la intrepretacion y uso de las etiquetas quemica, MSDS, la CFR 29, 1910.1200 (e) Estandarte, y la locacion en donde estos articulos son accessible a los empleados.

_____ _____
Supervisor o Mayordomo Fecha

I. INFORMING OUTSIDE CONTRACTORS

Outside contractors who are expected to work in areas covered by this hazard communication program must be informed of any potential hazards they or their employees may face while working in your facility, including:

- chemical inventory for the area(s) they will be working in;
- copies of appropriate MSDSs; and
- any additional information or materials that can be made available to the contractor for training his or her employees.

[NOTE: Managers and/or supervisors contracting for services of outside contractors are responsible only for training their own employees, and not for the contractors' workers. However, contractors are to be informed of their responsibility to their own employees, and given suggestions on protective measures.]

Review pages Z-101 through Z-117 in Volume 1 of the OSHA Reference Manual for additional elements contained in the hazard communication standard you may want to incorporate in your written program. In fact, the checklist found on pages Z-105 through Z-117 in Volume 1, photocopied and *fully* completed, might serve as an interim written hazard communication program until a more specific one can be adapted for your facility from the guidelines above. Also see pages 5-26f through 5-26t in Volume 2 for further information on labels, placards, and MSDSs.

SAFETY PROGRAMS FOR SPECIFIC INDUSTRIES AND OPERATIONS

Introduction

Subpart R of OSHA regulations for General Industry, which appears in Volume 1 of your *OSHA Reference Manual,* includes self-inspection checklists for: Pulp, Paper, and Paperboard Mills —1910.261; Textile Operations — 1910.262; Bakery Equipment — 1910.263; Laundry Machinery and Operations — 1910.264; Sawmills — 1910.265; Pulpwood Logging — 1910.266; and Telecommunications — 1910.268.

The Agricultural Operations, which had been covered by 1910.267, are no longer part of General Industry Standards. Reference to some aspects of agricultural operations continue to be included in your *OSHA Reference Manual* which touch on aspects of agricultural activities to which other standards apply.

This section of your Manual is being expanded to provide a series of program outlines to assist subscribers in more quickly understanding some of the General Industry Standards which may apply to a specific industry or operation. Each section of the outline will be cross-referenced, where applicable, to the checklists in Volume 1.

The outlines presented are *not* intended to be all inclusive and all-knowing — that would be an impossibility. Common elements associated with a particular industry will be addressed. Each subscriber will be responsible for filling in any needed safety activities to respond to a company's unique methods or procedures. It is suggested that you incorporate your own additional checklists to this section which would cover any special operation or equipment not already included.

Also, the outlines are intended to be used in conjunction with the basic "Safety Program Evaluation" system on page 5-1 of your *OSHA Reference Manual.*

(See other side for Contents Guide to Specific Industries.)

CONTENTS GUIDE TO
SAFETY PROGRAM OUTLINES:

Plastic Industries 5A-1

Hospitals 5A-7

Electronics Manufacturing 5A-13

Chemical Products Industries 5A-19

General Manufacturing 5A-29

Fabricated Metals Industry 5A-37

A. WALKING — WORKING SURFACES

(Reference: D-01 — 1910.22)

The following items should be considered major points in this area:

1. **Aisles:** The best rule of thumb should be: Can I walk from "here to there" in a clear, unobstructed manner? The aisles should be *marked* and kept clear of debris, equipment, and any other materials that always seem to have a habit of showing up. See the checklist referenced above for more detailed information.
2. **Working Surfaces:** If you've met item 1, you're halfway there. However, working surfaces have to be kept clear not only of the big, noticeable stuff, but also of wires, cables, tripping hazards, oiliness, and water. If you can't keep oil or water off the floor, try alternate means of making it safe, such as duck-boards. They're available in plastics, metal, wood, etc.

B. ACCESS TO MEDICAL RECORDS

(Reference: 1910.20) Basically, since you are using products considered toxic, you will be maintaining medical records on your employees. See the section referenced above for the "rules," and use the following as a general guide.

1. Keep in mind that your operation is unique in many ways. Therefore, read over the regulations on medical records access (they're available from any OSHA office). After doing this, if you have any doubts or questions, call the nearest OSHA office for guidance, or contact the OSHA editorial department at The Merritt Company. We will try to have one of our contributing Safety/-Health Consultants help answer your question(s).
2. Generally, an employee has the right to review his or her medical records. However, if he or she authorizes a representative to review them, the request to do so *must* be in writing.
3. If you receive a request for records that you are required to provide, you must honor the request, and allow the employee or authorized representative to make copies, if he or she so desires.
4. Generally, the request for the records must be specified (i.e., the employee must state what it is he or she wants to see, not just a general statement of, "Let me see everything you've got on me.").

C. EGRESS

(Reference: E-01 to E-02 — 1910.36 & .37)

1. Means of egress, or, basically, exits and the way to and from them, must be kept clear, *at all times.*
2. The route to the exits should be marked clearly, using striping and signs wherever possible.
3. The Fire Protection section in your Manual contains more information concerning exits.
4. Exit doors must be marked as such, and must be readily useable at all times. If security is a problem, you can't just chain them shut. Use *panic hardware* to prevent outside entry, or

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use audio alert devices so that a loud tone is given off if the door is open. Of course, if your operation shuts down completely at night, with no employee exposure, you can then lock up completely, but you must open up before any employees enter the premises.

D. POWERED PLATFORMS, MANLIFTS, AND VEHICLE-MOUNTED WORK PLATFORMS

(Reference: F-01 to-12 — 1910.66 to .68)

1. *All* of the above-named equipment must have certain basic safety factors:
   a. Means of securing so that equipment won't move when platform is in use.
   b. The platform itself must be firmly secured to the raising device, regardless of type.
   c. The platform must have guardrails. If the work being done requires an open side, the platform should be snugged up against the area it is servicing. If it can't be, the employee *must* wear a safety belt and line.
   d. The equipment must be maintained in good, working order, and must be designed for the work it is doing.
   e. Platform load limits should be posted in plain sight on the equipment. Load limits must *not* be exceeded.

E. OCCUPATIONAL HEALTH AND ENVIRONMENT CONTROL

(Reference: G-01 to -08 — 1910.94 to .95)

1. Your business is plastics. If you are handling chemicals, bulk melting plastics (PVC's, VC's, etc.), and related materials, effective ventilation and controls are needed. Regulations on PVC's exist, with specific requirements (addressed later in this outline). Ventilation design is important — make sure you do it right the first time, and save money and headaches in the future.
2. Ventilation systems must be monitored regularly for flow and proper operations.
3. Noise is a generally recognized problem in the plastics industry, particularly in grinding operations. If your grinders are chewing up plastics, you'll have noise. Have the noise levels monitored and analyzed. Know what your noise levels are and *document* the measurements. If the levels are higher than allowable, work to eliminate the problems by:
   a. Repairs, alterations to existing equipment, or replacement with better equipment.
   b. Providing hearing protection to exposed employees, *along with* a working, enforced hearing conservation program.
   c. Contracting out work processes which cannot otherwise be controlled.

F. HAZARDOUS MATERIALS

(Reference: H-01 to-78 — 1910.101 to .110)

1. Know your requirements concerning storage of compressed gasses and make sure your employees who handle and use them follow the rules you lay out.
2. Keep in mind that oxygen (compressed) cannot be stored with fuel gasses (such as acetylene, LPG, etc.). They must be separated either by a physical barrier with a fire resistance rating of one hour, or by a distance of 20 feet.
3. If you have flammable/combustible liquids, know your requirements and see that a program is in place at the work site to ensure safety. Some important considerations:
   a. Don't store oxidizers with flammables/combustibles.
   b. Keep flammables stored in approved safety containers and, if

bulk quantities are involved, in approved cabinets.

c. Clearly mark any areas containing the flammables/combustibles with NO SMOKING signs. *Enforce this rule.*

d. Make safety education an important activity for those working with the liquids.

G. PERSONAL PROTECTIVE EQUIPMENT

(Reference: I-01 to -04 — 1910.132 to .136)

1. Know what protective devices are needed (hard hats for overhead hazards, eye protection for chemical handling, and so on).
2. If a Personal Protection Equipment program is needed, research it well.
3. Set up your program and put it in writing.
4. Set up a training program to demonstrate care and use of equipment.
5. *Be prepared to enforce* use of required equipment.

H. MEDICAL AND FIRST AID

(Reference: K-01 — 1910.151)

1. Know where the nearest hospital is, and have a *plan* that you will use in the event a medical emergency arises.
2. If you choose, or are required to have, an in-plant first-aid program, consider all factors involved. Obtain good, practical supplies. Train key personnel in basic first aid. The best source for the training is the American Red Cross, but other sources are available (including private contractors who will train your people in-plant).
3. Have the telephone numbers of the hospital and local doctor and rescue/fire department posted on bulletin boards (See page 1-3 in Volume 1 for reproduceable posting form.)
4. Make certain employees also know what to do in the event of an emergency.

I. FIRE PROTECTION

(Reference: E-03, -04, -05 —1910.38 & .58; L-01 to L-24 — 1910.155 to .163)

1. You have a number of options in your approach to plant fire protection:
   a. A company fire brigade.
   b. An evacuation plan — evacuate all employees and let the local fire department handle fire fighting.
2. A Plant Fire Brigade is a serious business, requiring proper training, time, equipment, and knowledge. Your employees who are the fire brigade members may be exposed to additional hazards.
3. If you choose to have fire extinguishers and limited evacuation, you must have people trained in the proper use of those extinguishers.
4. If you choose to have an evacuation program, it must be in writing. The plan should include:
   a. Evacuation routes to be followed.
   b. "Form up" or reporting locations outside your facilities for evacuated employees.
   c. A "head count" system, so you know *all* employees have been evacuated.
   d. Personnel designated as fire wardens or similar title, to organize and oversee evacuation and to contact emergency agencies — police, fire dept, paramedics.
   e. Authorized, trained employees to shut down power, processes, utilities.
5. Fire sprinkler systems, and detection systems, must be routinely checked and well-maintained.
6. A final note: Your local fire department is a good source for assistance, training and general emergency education.

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J. COMPRESSED GAS AND COMPRESSED AIR EQUIPMENT

(Reference: M-01 to M-05 — 1910.166 to .169)

1. This ties into the previous section on Hazardous Materials.
2. If you're using compressed gasses in your operations, know the requirements for the system you have in place. The manufacturer of the equipment is a good starting point, and the regulations can help you better understand the overall safety picture.
3. Whatever the system, have a preventive maintenance/safety program in place.
4. If you are using air receivers, have them checked periodically for integrity, and internal scaling/rust. If the system is modified make certain it is still safe. Air receivers, if modified, require ASME welding, welders, and inspection.

K. MATERIALS HANDLING AND STORAGE

(Reference N-01 — 1910.176 to N-24 — 1910.184. Read headings & choose subject applicable to it.)

1. Have your forklift drivers trained, and keep a record of their training.
2. Store materials in a safe manner and in approved locations.
3. Aisleways should be wide enough to handle forklifts and their loads, *and* still leave enough room for a person to get by and out of the way.
4. In storing plastics, keep in mind their individual characteristics concerning heat, flammability, toxicity, and reactivity.

L. MACHINERY AND MACHINE GUARDING

(Reference: 0-01 to 0-24 — 1910.212 to 1910.219)

1. Know what types of machinery are being used in your operation: mixers; blenders; grinders; molders; extruders; pug mills.
2. Each machine should:
   a. Have two-hand trips for starting the machine's cycle.
   b. Have interlocked guards (i.e., if guard is opened, machine stops immediately) at *all* areas where access to the operating area is feasible. Don't make the assumption that it can't happen, just because it isn't an area that is readily accessible.
   c. Have a scheduled, documented prevented maintenance/safety program.
   d. Have operators and assistants trained in the *safe* operation of the machinery.
3. Where heat is a factor (as in the injection molders, vacuum molders, and the like), guard against burn hazards.
4. If a machine is modified, reevaluate the guarding on it.

M. HAND AND PORTABLE POWER TOOLS

(Reference: P-01 to P-05 — 1910.242 to .244)

1. Have a program that covers the use and care of these tools. Make sure employees know the requirements.
2. Make sure electrical tools are grounded. This cannot be over-emphasized.
3. Portable tool guards must be kept on the tool and not removed or by-passed in some way.

N. ELECTRICAL

(Reference: S-01 to S-29 — 1910.301 to .399)

1. Plant should have a good electrical system, built to do the job it is being called on to do. Installations should meet NEC (National Electrical Code) requirements where required, and should be installed by trained, fully-qualified personnel.

2. Personnel working on electrical equipment should, and must, have a mandatory "lock-out/tag-out" procedure in place. The "lock-out/tag-out" program should be strongly enforced, with employee awareness of what is involved. This means *all* employees, not just the electricians/maintenance personnel.

O. TOXIC AND HAZARDOUS SUBSTANCES

(Reference: Z-01 — 1910.1000 to Z-50 — 1910.1045. Select chemicals you use)

1. Know what materials you are dealing with. Obtain Material Safety Data Sheets on each of them from your supplier.
2. In the plastics industry, the vinyl chlorides are a major problem. Lead should also be considered as a possible problem in operations involving added-colors and products.
3. If PVC's are used, you must set up a monitoring program and supply personal protective equipment. Medical examinations and rechecks may be required, and made available at no cost to your employees.

P. MISCELLANEOUS

1. The following is supplied as general information, as a closing or summary to this program:

a. Obtain all the information you can on materials your company uses in the plastics operation and the related areas of operation.

b. Set up your program with management support, line supervision support and accountability training.

c. Have an on-going employee operation and safety education and training program.

d. Get to know your counterparts in the industry. Exchange of information in the safety field is very useful. Try joining the American Society of Safety Engineers, for example.

e. Look to your insurance company for assistance in supplying training aids, materials, ideas, etc.

f. Consider joining your local chapter of the National Safety Council.

g. Don't hesitate to ask questions of OSHA. OSHA's consultation service can be helpful.

h. Have an organized, written safety program. Use your *OSHA Reference Manual's* checklists and various forms. It will make things easier, and help save valuable time.

Next page is 5A-7

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SAFETY PROGRAM OUTLINE FOR HEALTH CARE FACILITIES

This outline is an overview of the major areas to be included in an occupational safety and health program for health care facilities. Federal OSHA standards are the basis for these checklists; however, health care facilities may also be subject to standards of other federal, state, or local agencies or jurisdictions. Examples include the state health department, the Joint Commission on Accreditation of Hospitals, the American Medical Association, and the American Hospital Association. Sections in this outline and specific OSHA standards are referenced in a checklist on the last page.

A. SAFETY PROGRAMMING

For a safety and health program to be effective in any type of facility, three basic elements are needed: 1) the full support of top-level management, 2) a written statement of objectives and goals, and 3) a written safety and health program. An effective occupational safety and health program will:

1. Meet on a regularly-scheduled basis
2. Designate responsible employees to head the program
3. Assign specific responsibilities for safety and health actions
4. Identify, remove, and control hazards
5. Ensure that all employees know how and when to report workplace hazards
6. Set up employee and supervisor safety and health training
7. Make certain new employees receive proper safety and health training before starting to work
8. Encourage employee input and feedback
9. Set up a safety and health record-keeping system
10. Emphasize the use of protective equipment and clothing

(For detailed information on how to set up a safety program, see the Yellow Tab, "Safety Programs," in Volume 2 of the *OSHA Reference Manual.*)

B. WALKING AND WORKING SURFACES

1. In wet and greasy areas (around dishwashers, sinks, and stoves), place no-skid material or no-skid mats on the floor to prevent employees from slipping.
2. Maintain a policy that all spilled foods, liquids, and breakage is to be cleaned up promptly. While waiting for cleanup, the areas should be marked.
3. Where work areas are slippery by nature, employees should have shoes that are the non-slip type.

C. ACCESS TO MEDICAL RECORDS

1. Employee medical records concern the health status of an employee and include:
   a. Medical and employment questionnaires or histories
   b. The results of medical examinations, including x-rays and biological monitoring

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c. Medical opinions, diagnosis, and biological monitoring

d. Description of treatment and prescriptions

e. Employee medical complaints

2. Employees have the right to review their medical and exposure records, particularly those on toxic materials. A deceased employee or former employee's legal representative may exercise the employee's rights.

3. When an employee requests copies of medical records, they should be supplied within 15 days, and at no cost to the employee.

4. The request for records should be specific, not a general statement requesting to see "all my medical records."

5. Employee medical records do not include physical specimens, records bearing on health insurance, or records of employee assistance programs, if kept apart from the medical records.

6. Employee medical records can only be given to others with the written consent of the employee.

7. Employee medical and exposure records must be kept during the time of employment, plus 30 years.

D. MEANS OF EGRESS

1. Means of egress, or basically exits and the way to and from them, must be kept clear at *all* times. This takes on additional importance in health care facilities, given the patient care/responsibility aspects.

2. The route to the exits(s) should be clearly marked. Use signs, striping, etc., whenever and wherever possible.

3. Exit doors must be marked as such and readily usable at all times. If security systems are used, they must be capable of being opened in a prompt and uncomplicated manner. If a door looks like an exit but is not, it should be marked "Not An Exit."

E. OCCUPATIONAL HEALTH AND ENVIRONMENTAL CONTROL

1. Know the premises. Know ventilation systems, problems, strong points.

2. A principal area of concern is Waste Anesthetic Gases. Some important points:

a. Perform Leak Testing on a continuing basis and keep records on volume of gases used versus leakage findings. The most common gases are nitrous oxide and halothane. The most frequent source of leakage is in the operating room, from the anesthesia equipment, associated with the anesthetist's or anesthesiologist's work practices.

b. Several anesthetic agents have chemical structures very similar to vinyl chloride and BCME (bis-chloro-methyl ether) which are known carcinogens.

c. Studies have shown (according to NIOSH) that operating room employees exposed to trace amounts of anesthetic gases suffer higher rates of leukemia and lymphoma (1.3 to 2 times more frequently than nonoperating room personnel).

d. Scavenging can be an important means of controlling this risk. A number of NIOSH[1] publications may be useful:

(1) *Development and Evaluation of Methods for the Elimination of Waste Anesthetic Gases and Vapors in Hospitals* — NIOSH Publication #75-137

(2) *Effects of Trace Concentrations of Anesthetic Gases on the Behavioral Performance of Operating Room Personnel* — #76-169

(3) *Criteria for a Recommended Standard . . . Occupational Exposure to Waste Anesthetic Gases and Vapors* — #77-140

[1]NIOSH is the National Institute for Occupational Safety and Health, headquartered in Cincinnati, Ohio. It is a federal governmental agency, and part of the Public Health Service/CDC.

3. Laboratory operations should be reviewed regularly. Ventilation should be checked regularly, and maintained in proper working condition. Any modifications to ventilation systems should be done only *after* the reason for the change is understood, and the change is shown to correct the problem and *not* worsen it or create a new one.

F. HAZARDOUS MATERIALS

1. Know the requirements concerning storage of compressed gases and make sure those handling and using them follow rules.
2. The American Compressed Gas Association's Pamphlet P-1 (*Safe Handling of Compressed Gases*) is a good reference source.
3. Bulk systems, for oxygen and other gases, are common in hospital operations. A standardized, routine but thorough check system and preventive maintenance program is essential in this area.
4. Where oxygen is stored, there must be a minimum clearance of at least 20 feet from any flammable or combustible gases.
5. Know what chemicals are used and obtain Material Safety Data Sheets for each. Read them and act accordingly.
6. Flammable and combustible liquids storage regulations should be strictly adhered to. Some important thoughts:
   a. Don't store oxidizers with flammables/combustibles.
   b. Keep flammables stored in approved safety containers and, if bulk quantities are involved, in approved cabinets.
   c. Clearly mark any area containing flammables/combustibles with No Smoking signs and enforce this rule. Remember that educating those working with flammables/combustibles is important.

G. PERSONAL PROTECTIVE EQUIPMENT (PPE)

1. Know what is needed and where (eye protections, respirators, hard hats, and the like) and then supply the needed protection. Require them to be used.
2. If a PPE program is needed, research the subject carefully. A well-planned program will give you the edge and will allow it to work.
3. Follow through on the program. Set a good example and obtain top management cooperation.
4. Use gloves where blood, blood products, or body fluids will be handled.
5. Use gowns, masks, and eye protectors for procedures which could involve more extensive splashing of blood or body fluids.
6. Wash hands thoroughly after removing gloves and immediately after contact with blood or bodily fluids.
7. Use disposable needles and syringes whenever possible. Place sharp instruments in a specially designated, puncture-resistant container located as close as practical to where the needles are being used.
8. Follow general guidelines for sterilization, disinfection, housekeeping, and waste disposal.
9. Educate employees in the prevention of transmission of infectious diseases.
10. The threat of Hepatitis B, AIDS, and HIV transmission makes the use of PPE even more critical in health care setting. For specific precautions, see section N.

H. FIRE PROTECTION

1. Have a written plan, with responsibilities clearly assigned.
2. Train personnel in emergency evacuation. Educate employees on how to protect patients and themselves in emergency situations.

3. Have employees trained in the proper use of fire extinguishers.
4. An evacuation program must have certain key elements:
   a. Have assigned, clearly designated, and posted evacuation routes.
   b. Have assigned "form up" locations outside the hospital, so employees can meet after evacuation and a reasonable head count can be made of employees and patients.
   c. Designate key personnel as fire wardens, to organize and oversee evacuation.
   d. Have a clear, distinct means of alerting employees to evacuate. PA systems sometimes have a notorious habit of sounding like gibberish. A tone alert signal might be a better way of alerting personnel.
5. Have a routine, reliable check system set up to ensure that fire sprinkler systems and alarm/smoke/fire detection systems are functioning.
6. Local Fire Departments are an excellent source for assistance, training, and general fire safety education. Regulatory questions concerning OSHA requirements should, however, be addressed to your local OSHA office.

I. MATERIALS HANDLING AND STORAGE

1. Store materials in a safe manner.
2. Know what is being stored and keep records. Educate personnel in proper and safe storing procedures.
3. Mark all physical hazards according to the safety color code.

J. MACHINERY AND MACHINE GUARDING

1. If your hospital has its own maintenance department (chances are a machine shop is somewhere on the premises), here are some things to remember:
   a. Grinders should have guards in place when abrasive wheels are in use. They should be adjusted to within 1/8-inch of the wheel (top tongue guard and work rest). The machine should be grounded electrically.
   b. Portable tools should have guards in place.
   c. Have a review program for maintenance personnel to use for checking their operations.
2. Personnel using machines should be trained to use them in a safe manner.
3. Ground electrical tools; if tool is double-insulated it must say so on the tool.
4. Mark all physical hazards according to the safety color code.

K. ELECTRICAL

1. Know the National Electrical Code requirements for Hospitals. This is in addition to the OSHA requirements.
2. Set up a good, thorough, scheduled electrical safety program/check system.
3. Personnel working on electrical equipment and conducting the safety checks should be fully qualified and thoroughly trained.

L. TOXIC AND HAZARDOUS SUBSTANCES

1. Know what materials you are dealing with. Obtain and file Material Safety Data Sheets for all such substances. Maintain accurate, audited records of substances and quantities.
2. If in doubt, check it out. Don't make assumptions.
3. In this realm, consider also the following
   a. Biological hazards — know what they are, how they must be handled, contained, and disposed of.

M. HIV/HEPATITIS B PRECAUTIONS

Acquired Immunodeficiency Syndrome (AIDS), caused by the Human Immunodeficiency Virus (HIV), and the Hepatitis B Virus require special precautions of health care workers. *Health care workers* is defined as

persons, including students and trainees, whose work involves contact with patients or with blood or other body fluids from patients in a health care setting. OSHA does not have a standard on the prevention of HIV transmission in health care settings, but does use recommendations from the Centers for Disease Control (CDC). Copies of *Recommendations for Prevention of HIV Transmission in Health-Care Settings* can be obtained through the National AIDS information Clearinghouse, P.O. Box 6003, Rockville, Maryland 20850.

The CDC recommends the following precautions:

1. All health care workers should routinely use appropriate barrier precautions to prevent skin and mucous membrane exposure when contact with blood or other body fluids of *any* patient is anticipated.
2. Gloves should be worn when touching blood and body fluid, mucous membranes, or non-intact skin of all patients, when handling items or surfaces soiled with blood or body fluids, and when performing venipuncture and other vascular access procedures. Gloves should be changed after contact with each patient. Hands and other skin surfaces should be washed immediately and thoroughly if contaminated with blood or body fluids. Hands should also be washed immediately after gloves are removed.
3. Masks and protective eyewear or face shields should be worn during procedures that are likely to generate droplets of blood or other body fluids to prevent exposure of mucous membranes of the mouth, nose, and eyes.
4. Gowns or aprons should be worn during procedures that are likely to generate splashes of blood or other body fluids.
5. All health care workers should take precautions to prevent injuries caused by needles, scalpels, and other sharp instruments.
6. Needles should not be recapped by hand, or purposely bent or broken by hand. After they are used, disposable syringes, scalpels, blades, etc., should be placed in puncture-resistant containers for disposal. The containers should be located as close as practical to the use area. Large-bore, reusable needles should be placed in a puncture-resistant container for transport to the reprocessing areas.
7. Although saliva has not been implicated in HIV transmission, to minimize danger in mouth-to-mouth resuscitation, mouth pieces, resuscitation bags, or other ventilation devices should be available for use in areas where resuscitation may take place.
8. Health care workers who have exudative lesions or weeping dermatitis should refrain from all direct patient care and from handling patient-care equipment until the condition is resolved.
9. Pregnant health care workers should be especially familiar with and strictly adhere to precautions to minimize the risk of HIV transmission.
10. Universal blood and body-fluid precautions should be used when dialyzing patients.
11. HIV preventive measures should be incorporated into isolation procedures.
12. In laboratories, fluids from all patients should be considered infectious.

N. HAZARD COMMUNICATION

The Hazard Communication Standard ensures that employees in all industries are given notice if chemical hazards are used in the workplace. Under the standard, employers must:

1. Have a written communication program to provide information to employees. The program must include:
   a. A list of the hazardous chemicals in each work area
   b. The means to tell workers of the hazards of routine tasks
   c. The hazards of chemicals in unlabeled containers

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2. Make sure containers have the proper labels and warnings.
3. Make Material Safety Data Sheets available to employees.
4. Design and carry out a training program on hazardous chemicals for employees. This should include:
   a. Requirements of the hazard communication standard
   b. Operations where hazardous chemicals are present
   c. Location of information on the hazardous chemicals
   d. Instructions on reading and interpreting MSDS's
   e. Protective measures workers can and should take
   f. Use of personal protective equipment
   g. Measures that alert workers to hazardous chemicals

O. RADIATION SAFETY

While a hospital has special requirements relating to radiation, the elements of a radiation safety program apply wherever ionizing or non-ionizing radiation is a factor. Generally, employees are more concerned about ionizing radiation, which includes radioactive material. Lesser, but important emphasis, goes to non-ionizing radiation such as radar, microwave ovens, infrared inspection equipment, and high-intensity lights. Elements of a program should include:

1. An administrative plan to assure that the use of radioactive material and/or radiation meets with state and federal laws and regulations.
2. An operational program to assure the safety and health of employees and the public who may be exposed to radioactive material and/or radiation.
3. A recordkeeping program to show compliance with laws and regulations, to document exposure, to document releases to the environment, and to generate a file of evidence for potential defense of liability suits.
4. An education and training program to teach employees how to safely handle radioactive material and/or radiation.

P. HAZARDOUS WASTE AND EMERGENCY RESPONSE

Special regulations apply to employers and employees engaged in:

1. Hazardous substance response operations that are under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA).
2. Operations that involve hazardous waste storage, disposal and treatment facilities under the Resource Conservation and Recovery Act (RCRA).
3. Hazardous waste operations that have been designated for by state or local governments.
4. Emergency response operations for releases of hazardous substances and post-emergency response operations for such releases.

Q. INFECTIOUS WASTE MANAGEMENT

Infectious waste — solid or liquid — is a major concern in health care facilities. The following precautions should be taken:

1. Persons who handle infectious waste should receive an appropriate orientation, equipment, and on-the-job training.
2. Each department handling infectious waste should have specific written policies and procedures on the identification, safe handling, packaging, storage, transport, and disposal of these wastes.
3. An Infection Control Nurse should be given the authority to enforce hospital policies on infection control in an emergency.
4. Infectious waste should be classed by an Infection Control Committee as follows:
   a. Pathology wastes
   b. Microbiology waste

c. Sharps (syringes, needles and scalpels)

d. Blood and blood products in liquid form

5. The classifications of infectious waste should be reviewed at least annually.
6. All waste from patient care areas should be handled as if it were infectious.
7. Dispose of liquid blood and other liquid body fluids directly into the sanitary sewer system without pretreatment.
8. Place microbiology wastes directly into autoclavable bags in the microbiology lab.
9. Place surgical and pathological wastes in distinctive waste bags.
10. Place needles and sharps in disposable, rigid, puncture-proof containers.
11. Immediately clean up any spills of infectious wastes and disinfectant in the area.
12. Report all spillages through the health care incident reporting system.
13. Transport infectious wastes to the incinerator by the most direct route in fully enclosed collection containers.
14. If infectious waste cannot be disposed of on-site, prepare it as described above for delivery to the contractor's container.
15. Make certain the contractor handles the waste in an approved manner and has all the valid permits to dispose of infectious waste.

R. EMERGENCY AND DISASTER PREPAREDNESS

1. Emergencies are unpredictable; however, a sound emergency/disaster plan can often prevent an incident from becoming a major disaster, or can greatly reduce damage caused by an emergency. Types of emergencies and disasters include:

   a. Fire

   b. Explosion/bomb threat

   c. Flood

   d. Hurricane

   e. Tornado

   f. Earthquakes

   g. Civil strife

   h. Sabotage

   i. Strikes

   j. Chemical spill/vapor release

   k. Radiation

   l. Extreme weather

   m. Nuclear events

   n. Energy emergencies

   o. Kidnaping and extortion

2. Assess the probability of the above emergencies, and determine the hazards involved.
3. Designate an emergency/disaster coordinator who has the authority to develop, test, evaluate, and implement a plan.
4. Develop an emergency/disaster plan, and have it approved at the top level.
5. Train necessary personnel on how to react to certain emergencies.
6. Test the plan to find gaps and flaws. Critique a test immediately after it takes place so that uncovered problems can be quickly corrected.
7. Revise the plan as needed.

S. CONCLUSION

1. Obtain all the information you can on materials in use, including how used, how disposed of.
2. Set up your program with management support, line supervision support and responsibility, and employee support and training.
3. Get to know your counterparts in your industry. Exchange of information in the safety field is very useful. Try joining, for example, the American Society of Safety Enginners.
4. Seek the assistance of your insurance company. Use whatever you feel is best from what they have to offer, then tailor it to your needs.

5. Don't hesitate to ask OSHA questions. They can be of service in many instances.
6. Have an organized, *written* safety program to work from. It serves as a starting point and a reference source.
7. Make use of the *OSHA Reference Manual's* checklists and various forms. They will make things easier and will save you time.
8. When looking through the checklists in Volume 1 of the *Manual*, select applicable sections by heading.
9. Call or write us at The Merritt Company if you need assistance with a particular technical question or problem.

FEDERAL OSHA CHECKLIST
29 CFR 1910

Item	Standard	Tab/Page
Gloves	1910.132	I-01
Resuscitation Equipment	1910.132	I-01
Gowns	1910.132	I-01
Sanitation	1910.132	I-01
Hand Washing	1910.141	J-02
Cleaning of Blood and Spills	1910.22	D-01
Room Cleaning	1910.22	D-01
Biohazard Tags	1910.145	J-07
Waste Disposal	1910.141	J-01
Color Coding	1910.144	J-05
Walking and Working Surfaces	1910.21-.22	D-01
Access to Medical Employee Records	1910.20	C-01
Means of Egress	1910.36-.37	E-01
Environmental Controls	1910.94-.95	G-01
Hazardous Materials	1910.101-.120	H-01
Personal Protective Equipment	1910.132-.136	I-01
Fire Protection	1910.36-.38	E-01
Materials Handling and Storage	1910.176	N-01
Machine Guarding	1910.212-219 & 1910.144	O-01 J-08
Electrical	1910.301-.339	S-01
Toxic & Hazardous Substances	1910.1000-.1450	Z-01
Radiation Safety	1910.96-97	G-09

(Next page is 5A–13)

S10

SAFETY PROGRAM OUTLINE FOR ELECTRONICS MANUFACTURING

This program outline is intended to provide a general overview of activities normally encountered at facilities involved in manufacturing and processes associated with the production of electronic devices and equipment. This outline should presently be used only as a guide, in conjunction with those portions of the *OSHA Reference Manual* which apply to your kind of facility and operation (in particular the self-inspection checklists which conform to the OSHA standards for General Industry).

Your facility and operation may have special and unique equipment, or make use of specialized processes for which you may want to add safety program measures of your own. If so, it is advisable to incorporate such procedural notes in the appropriate sections of your Manual or to this outline.

Some of the areas that are of particular importance when looking at safety and health in the electronics manufacturing field include:

1. *Wave soldering operations* — ventilation, degreasing agents, and protection of hands against those agents.
2. *"Hand" soldering operations* — ventilation, fluxes and their problems, melting of wire insulation and its by-products problems, and safe soldering-iron stands.
3. *Ergonomics* — the "work station" layout for maximum efficiency, safety, and comfort.
4. *Lighting* — while lighting is not a regulation of great detail, it is important for safe *and* accurate operations.
5. *Use of Cathode Ray Tubes (CRT's) and related equipment* — proper antiglare measures and proper work-cycle lengths to avoid fatigue (and subsequent inaccuracies).
6. *Machine guarding* — wire stripping machinery, wire cutting/measuring equipment, and cable-makers.
7. *Noise* — you may have a problem; it bears looking at.
8. *Eye protection* — against stray pieces of just-clipped multistrand wires, solder spatter, and the like.
9. *Chemicals* — what do you use for cleanup, pre-tinning prep, and the like?

The above areas are just some of the things you should be thinking about. The following material will not cover everything just mentioned, but you will get a good feel of many regulations which may apply.

Use the whole "package" and you'll have a good head start into making a truly useful and rewarding safety/health program.

A. WALKING — WORKING SURFACES

(*Reference: D-01 — 1910.22*)

If you run a business, you have walking/working surfaces. If they aren't in shape, trouble follows. Some of the important points include:

1. Aisles: Keep them clear! They should be wide enough to walk down without getting run over by other employees

and/or material handling equipment and their usual loads (e.g., forklifts carrying cartons of parts). Mark the aisles so it's clear where they are. *Enforce* a "keep the aisles clear" policy.

2. Walking/Working Surfaces: If you take care of Item 1, this falls right into place. Keep things from accumulating in aisles, under workbenches, or in corners. Keep floors clear of water and oily materials. Don't allow tripping hazards (such as wires, pipes, or conduits) to be placed across walkways.

B. ACCESS TO MEDICAL RECORDS

(*Reference: C [entire section] — 1910.20*)

We recommend you review the checklist contained in the "Self-Inspection" section of the Manual. However, keep in mind a few major points:

1. If you are using something that exposes your employees to an occupational health hazard, and medical records and monitoring records are to be kept, then you fall under requirements of the Access standard.
2. The standard doesn't add anything to recordkeeping — it requires that you allow access to your existing and future records, where applicable.

C. EGRESS

(*Reference: E-01, E-02 — 1910.36 & 1910.37*)

Egress (exit) from your premises is an important and vital part of any safety program. *Plan Ahead Now.*

1. All means of egress and the routes to them *must* be kept clear at all times.
2. Exits and exit routes should be clearly marked. This can make the difference between life and death in an emergency.
3. Exit doors cannot be locked in a fashion that would make their use difficult or impossible in an emergency. "Panic" hardware, along with alarm devices, should be used if doors must be secured from outside entry or unauthorized inside use.
4. The Fire Protection section of this program guide contains more information concerning exits.

D. POWERED PLATFORMS, MANLIFTS, AND VEHICLE-MOUNTED WORK PLATFORMS

(*Reference: F-01 to F-12 — 1910.66 to 1910.68*)

You may have an operation involving some or all of this equipment (for maintenance, stock-picking, etc.). If so, here are some important points, applying to *all* equipment of this type:

1. There must be means of securing the equipment so that it will not move while the platform is in use.
2. The platform itself must be securely attached to the raising device, regardless of type. *Don't* use wood pallets on your forklift as a work platform!
3. The platform should be equipped with guardrails. If this is impractical, employees must have safety belts, *and* their use must be enforced.
4. Maintain equipment in good operating order. Defective units must be removed from operation immediately and should not be used again until they are repaired.
5. Platform load limits must be posted in plain sight on the equipment. Load limits are never to be exceeded.

E. OCCUPATIONAL HEALTH AND ENVIRONMENTAL CONTROL

(*Reference: G-01 to G-08 — 1910.94 & 1910.95*)

If your operation includes wave-soldering machinery, and employees involved with soldering using hand-held soldering irons, you must consider the following:

1. Is the wave-soldering equipment (or any similar automated P.C. Board equipment involving soldering) properly ventilated?
2. Do you know what degreasing agents

are being used? Do you have Material Safety Data Sheets on them?

3. Are work stations for hand soldering work properly ventilated, or is the employee's breathing zone being filled with vapor or fumes from the solder and fluxes?
4. See Section O of this guide concerning toxic substances.
5. Do you have any operation that has a high noise level? It's not customary in electronics, but it *is* always possible. A good rule of thumb: If your normal voice level can't be heard in a work area, start checking exposures to excessive noise levels.
6. If involved in making "chips," what chemicals are in use?

F. HAZARDOUS MATERIALS

(*Reference: H-01 to H-78 — 1910.101 to 1910.110*)

If you're in business today, the odds are you have chemicals on board, including flammables/combustibles. Along with those, you may also be using compressed gases. Here are some points to consider:

1. Know your requirements concerning storage of compressed gases and make sure those handling them follow the rules *you* lay out.
2. Keep in mind that compressed oxygen cylinders cannot be stored with fuel gases (such as acetylene, LPG, and the like). A physical barrier, with a fire resistance of one hour or more, must separate the oxygen from the fuel gas cylinders, or a physical distance of 20 feet can be used.
3. If you have flammable/combustible liquids in use or storage, know your requirements for use and handling, as well as storage limitations. These vary from jurisdiction to jurisdiction (i.e., fire departments of different towns, cities, etc. may have different requirements). Some important considerations:
   a. Don't store oxidizers with flammables/combustibles.
   b. Store flammables in approved safety containers. If bulk quantities are involved, use approved storage cabinets or properly designed and built storage rooms or areas. If in doubt, ask your local fire department for help *and* double-check with your local OSHA office.
   c. Clearly post "No Smoking" signs in appropriate areas and strictly enforce the rule!
   d. If work stations use flammables/combustibles in liquid form for their work, use approved safety dispensers. Don't use open containers of liquid!
   e. Train and *educate* employees in proper use and handling of these liquids.

G. PERSONAL PROTECTIVE EQUIPMENT

(*Reference: I-01 to I-04 — 1910.132 to 1910.136*)

Degreasing agents, cleaners, and related chemicals can create dermatological problems. Wire cutting can create eye hazards, as can soldering. Some preparation is needed, as well as some thought. Consider:

1. What is needed? If eye protection is required, study the problem. Don't go into a plant-wide program if it is a departmental problem.
2. Supply hand creams, gloves, and the like in areas that have employees exposed to degreasers, cleaners, etc. *Don't wait* for dermatitis to set in, and don't be skimpy with supplies. If hands are needed to work a job, they're not much use if they're in bad shape.
3. Any program you set up needs the support of all levels of management. This is especially important in personal-protective equipment cases.

H. MEDICAL AND FIRST AID

(*Reference: K-01 — 1910.151*)

Here are some important things to remember:

1. Have an emergency action plan.

Emergency telephone numbers should be posted by all telephones.

2. If you choose, or are required to have, an in-plant first-aid program, consider all factors involved; obtain good, practical supplies; train key personnel. The best source for training is the American Red Cross, but other qualified sources are available (including private contractors).
3. Educate employees in what to do in the event of a medical emergency.

I. FIRE PROTECTION

(*Reference: E-03 to E-05 — 1910.38 & 1910.58 — L-01 to L-24 — 1910.55 to 1910.163*)

1. You have a number of options in your approach to plant fire protection and planning:
   a. Fight fire yourself using a company fire brigade.
   b. Evacuate all employees and let the local fire department handle it.
2. A plant fire brigade is an *option* only, and should be carefully considered. You are permitted to have two levels of brigades: full structural fire fighting and/or limited "fire extinguisher/fire hose" brigades.

   If you go the full structural route, you must then meet protective gear, training, and other requirements. If you go the fire extinguisher route only, you must properly train assigned employees in the use of extinguishers and fire hoses, if you have them in your facility.

   The choice, of course, is yours. Talk with your local fire department. (If it's volunteer, you may have some of its members on your payroll — seek them out for help.)

   One final point: If you go with a full brigade approach you will be exposing the brigade members — your employees — to the very distinct hazard of fighting fires.
3. If you choose the evacuation program (perhaps the easiest approach), you must meet the following criteria:
   a. It must be in writing, stating who is in charge and where.
   b. Have given, designated evacuation routes.
   c. Have specific "form up" areas outside the plant(s), where employees can go after leaving the building(s).
   d. Have a "head count" system, so you know everyone's out and accounted for.
   e. Your designated fire wardens must be known to your employees. A distinctive hat, vest, or the like would help make them readily visible.
   f. Have a clear, distinct, unique sounding means of alerting employees to evacuate.
4. You must maintain your sprinkler systems (if you have them) and detection systems (if you have them) in full working order. They must be checked and maintained on a regular and documented basis.
5. A final note: Your local fire department is usually a good source for assistance, training, and general fire safety education.

J. COMPRESSED GAS AND COMPRESSED AIR EQUIPMENT

(*Reference: M-01 to M-05 — 1910.166 to 1910.169*)

1. If you're using compressed gases in your operations (cylinders and/or bulk systems), know what you're dealing with. The manufacturers and suppliers are good sources for much of the information you'll need.
2. Have a preventive maintenance system in place, and monitor it regularly, but randomly, to assure its effectiveness.
3. A final point: If you are using air receivers, have them checked regularly for integrity, internal scaling, or rust. And, if you modify the equipment, you *must* have it done by ASME welders, with an ASME-certified inspection following the work. This step should not be overlooked. A company in the west had not done this, and had

even patched a small hole in the receiver. The hole had appeared because the internal rust was so bad that the wall thickness had virtually reached a paper-thin quality. The tank blew and, while not killing the employee nearby, did manage to remove a large part of that employee's shoulder and upper arm.

Remember this: A "low pressure" system is a deceiving and relative term. For example, a "15 psi" system is a relatively low-pressure system (when you look at other systems running at, say 150 psi). However, 15 psi means 15 pounds per square inch. Figure out how many square inches are inside that tank and multiply by 15 pounds. You're looking at an overall, and very impressive, high level of pressure. Don't Forget This!

K. MATERIALS HANDLING AND STORAGE

(*Reference: N-01 — 1910.176 to N-24 — 1910.184 — Read the headings and choose subject applicable to your operations*)

1. Have your forklift drivers trained and keep a record of that training.
2. Store *all* materials in a safe manner — interlock boxes where you can. Refer back to the Hazardous Materials Section (F) in this program guide for additional information.
3. If you're storing plastics, keep in mind their individual characteristics concerning heat sensitivity, flammability, and toxicity.
4. Look over the whole picture in your storage area(s).

L. MACHINERY AND MACHINE GUARDING

(*Reference: O-01 to O-24 — 1910.212 [Very Important] to 1910.219*)

1. Know what machinery is being used. Do you have wiring measuring machinery? Automated wire measuring/cutting equipment? Crimping machinery for those electrical connections?
2. Each machine should be guarded at its point of operation and in any other part of its layout where employees can come in contact with its mechanisms and be injured. Consider:
   a. Caging, with interlocks on doors (if door opens, machine stops).
   b. Two-hand trips at point of operation to prevent operator from placing hands in danger zone.
   c. "Presence sensors" that can tell if someone is entering the danger zone and stop the machine.
   d. Train and educate operators and related personnel on safe operation. Enforce the use of safety systems.
   e. Have a firm and enforced policy requiring locking out/tagging machinery and power or energy sources when machinery is being serviced, or undergoing repairs or maintenance.
3. If heat is used in the process, guard against burns.
4. If you modify a machine, *always* reevaluate the safety equipment on it. A few years ago a company added a robot to unload an injection-type machine but didn't reevaluate. The robot couldn't detect people, and an employee got near the casting area. The robot cycled the employee right into the point of operation.

M. PORTABLE, HAND-HELD TOOLS

(*Reference: P-01 to P-05 — 1910.242 to 1910.244*)

It is advisable to include this area in your safety program. The following points should be considered:

1. Make absolutely sure all electrical tools are either grounded or double-insulated. If they're double-insulated, they'll be identified as such on the tool's casing. If it doesn't say it on the casing, don't believe it. Make sure your outlets are functioning with respect to the ground.
2. Are portable tools equipped with guards? Guards should not be removed or modified.

N. ELECTRICAL

(*Reference: S-01 to S-29 — 1910.301 to 1910.399*)

1. Your plant should have an electrical system that:
   a. Can handle the current demands placed on it.
   b. Meets National Electrical Code requirements (and OSHA requirements).
   c. Is maintained and changed by qualified personnel only.
   d. Is handled with a good, working lock-out/tag-out system to prevent electrocution of people working on the electrical equipment and related systems.

O. TOXIC AND HAZARDOUS SUBSTANCES

(*Reference: Z-01 to Z-50 — 1910.1000 to 1910.1045* — Review and select those chemicals *you use*)

1. Know what you're dealing with!
2. Obtain Material Safety Data Sheets. If your supplier won't supply them, try another supplier, if at all practical.
3. In the electronics industry, a wide range of chemicals are used, and it's impossible to address them here. Some important operational areas where hazardous substances may be in use are:
   a. Degreasing
   b. Wave soldering
   c. Use of fluxes in wave and hand soldering
   d. Cleaning of equipment
   e. Photographic work
   f. Hand-soldering operations — fumes and vapors from melting solder
4. If you have a problem, call your local OSHA office and ask to speak to an industrial hygienist or for the consultation services. They are specifically trained in this area and will do their best to assist you. You can also contact The Merritt Company and we'll put you in touch with one of our Consultant-Author/Editors.

P. MISCELLANEOUS

Here are some things to remember:

1. Know what you're dealing with.
2. Obtain all the information you can on any and all materials your company uses in making the product from beginning to end.
3. Set up your safety/health program with management and line-supervision support, responsibility, and accountability, as well as employee education and participation.
4. Get to know your counterparts in your industry. Exchange information in the safety field — it can really pay off. Consider joining the American Society of Safety Engineers.
5. Use your insurance carrier as a resource for films, literature, posters, and training sessions.
6. Don't hesitate to ask questions of OSHA's consultation services. They can be helpful.
7. Have an organized, written and realistic safety program.
8. Make use of the *OSHA Reference Manual*. The checklists and forms can save you time and effort.
9. When looking through the checklists in Volume 1 of the *OSHA Reference Manual*, select those things that apply to your company.
10. Don't hesitate to call or write The Merritt Company if you have any questions or need assistance with a technical problem. We'll do our best to help.
11. Use the *OSHA Reference Manual*'s appendices for helpful "fill-in" data (located at the end of Volume 1).
12. Using this program guide, the checklists, and professional contacts with others in your industry will allow you to get a head start on what can be a good, workable, and realistic safety program for you.

SAFETY PROGRAM OUTLINE FOR CHEMICAL PRODUCTS INDUSTRIES

In addition to the normal safety and health conditions and operations found in all industries, the chemical products industry has a greater potential for hazards associated with the broad range of materials and processes unique to the industry.

The size, quantity, types of chemical products, and the processes and the methods required to control the potential hazards will vary greatly from plant to plant in this industry. Extra caution may be needed in the area of fire prevention. The potential for ordinary fire and explosion hazards are increased because of the flammability and explosive nature of many chemicals used in the industry.

REACTIONS TO CHEMICAL EXPOSURE

Overexposure to certain chemicals which may affect an employee's judgment or reaction time may go unnoticed. This overexposure may be the root cause of accidents, such as slips or falls, which may have been reported or categorized as due only to a physical hazard. Some illnesses, such as sensitivity to a chemical with which an employee has worked with for a considerable length of time, could cause an erroneous diagnosis due to its being confused with other conditions that present a similar clinical picture.

Frequently, the long interval that exists between exposure to a chemical and the occurrence of a disease makes recognition more difficult because of the problem of relating cause with effect. An excellent example of this is where a rare form of liver cancer was associated with the use and production of vinyl chloride.

Any general approach to controlling occupationally induced illnesses must recognize some of the difficulties that may exist in your plant. Your program must be instructed to minimize employee exposure to all chemicals that are used.

This program outline is not intended to be all-encompassing. Nor does it attempt to delineate all of the hazards that may actually exist in all plants. It is intended to generate thoughts and ideas that can be utilized by you in conjunction with the *OSHA Reference Manual* — especially the applicable self-inspection checklists — to enable your plant to improve production and quality assurance through a practical safety program.

The first portion of this program outline deals with the considerations that should be given to the chemical hazards your employees may encounter in their work.

A. NATURE OF THE HAZARD

1. Accumulate all the information possible about the risks associated with the processes and chemicals involved.
   a. Obtain the desired information from consultants, or;
   b. Request that suppliers provide you with Material Safety Data Sheets (MSDS) on all products purchased. Have your purchasing department note on purchase orders that a data sheet is required. Most manufacturers and/or suppliers have these sheets available for their individual products.

c. Read available published literature, or;

d. Make an inventory of every product used to ensure a complete assessment of the potential problems tha may be encountered.

B. HAZARD EVALUATION

1. Evaluate the potential hazards (chemical, physical, mechanical) and the methods of control that can be used.

   a. The methods of control will vary considerably depending upon the extent and nature of the hazards present in each different process.

   b. Due to the problems associated with the storage and separation of noncompatible chemicals — explosives and flammables — there must be separate warehousing controls established.

   c. Engineering controls have always been the best method for controlling hazards. If the hazard is eliminated, there will be no accident or injury.

   d. For high-risk hazards or areas, it may be necessary to provide total enclosure of an operation or process.

   e. It may be necessary to increase the distance between various hazardous areas or buildings to preclude any catastrophic incidents by: separating processes into buildings and/or rooms; separating nonhazardous areas such as offices, workshops, etc., from the hazardous areas; and separating processing and storage facilities for different manufacturing processes.

   f. The quantities of chemicals involved in the various operations should be limited.

   g. Off-site or on-site air and water effluents must be adequately controlled in order to prevent a hazardous condition.

   h. Consideration should be given to limiting the number of workers involved in high-risk areas or operations.

   i. Less hazardous materials should be substituted whenever possible.

   j. Provide training for employees so they have a full understanding of the properties and hazards of the chemicals and processes.

C. IMPLEMENTATION

1. Management should consider the above items and any other conditions you uncover, and make an evaluation of the problems found. These should be well documented for appropriate action. It may be wise to establish a timetable for the survey to be accomplished.

2. If you are contemplating the design or modification of a plant, and there are unanswered questions as to the appropriate specifications involved in the overall health and safety programs of those items covered in B. above, management should consult with an industrial hygienist or design engineer. The primary emphasis should be on "engineering out" any potential problem or hazard areas.

3. Consideration should also be given to protecting employees or operators should the design or built-in safety measures fail. Personal protective equipment can provide this protection, but should never be utilized in lieu of adequate engineering controls. If personal protective clothing and equipment are to be made available, they must be properly utilized, simple to use, and comfortable.

4. Atmospheric measurements may be necessary to ensure that levels of toxic materials are below the appropriate TLV (threshold limit value) of the federal standard (1910.1000 —page Z(a)-02 of the *OSHA Reference Manual*). It may be necessary to have medical monitoring of each employee to discover any deviation from normal health patterns. The frequency and type of these examinations are matters for a physician to decide, in consultation with an industrial hygienist.

The second part of this program consists of general safety hazards encountered in most industries.

A. INTRODUCTION

An effective safety and health program will require the following minimum items:

1. A written statement of objectives and goals.
2. The demonstrated support of top-level management and supervisory personnel in the company safety program.
3. A written program that outlines the broad objectives in order to ensure a safe and healthy place of employment.
4. A designation, in writing, of the person who will have the responsibility to ensure that the program is implemented and adhered to.
5. The cooperation of all employees of the organization and encouragement by management for employees to provide input on hazards and safety suggestions. Input by employees will also require feedback from management on all items suggested.

B. WALKING AND WORKING SURFACES — GOOD HOUSEKEEPING

(Reference: D-01 — 1910.22)

1. If good walking and working surfaces are not provided, the management of any organization, large or small, faces a multiplicity of problems in ensuring a safe place of employment. Messy conditions and faulty housekeeping do not encourage good production attitudes among employees.

   In fact, if employees are not encouraged to practice good housekeeping methods, such as picking up scrap material as the work progresses, it will be very difficult for the safety program to succeed in an orderly manner.

   We have stated in previous articles of this Manual that safety inspectors, whether with a government agency, insurance carrier, or private consultant, rely heavily upon their initial observations when entering the plant. If the work areas are cluttered with scrap or material not in use, they have the tendency to think that management has no genuine interest in safety and health programs. They are then inclined to look closely at all aspects of the plant as the inspection progresses.
2. The usual method for controlling housekeeping is to have designated areas for all scrap and unused materials. This may necessitate a continuing program of informal training on the part of all supervisory personnel to ensure good control. Your motto should be "a place for everything and everything in its place."
3. In chemical products industry plants, there are usually wet processes and tanks or vats in use. If this is the case in your plant, it will be necessary for extra precautions to be taken to quickly eliminate slippery conditions as they occur to prevent the accidental slipping of employees. It will also require that floors have proper drainage for liquids. The use of duck boards or false floors are strongly encouraged.
4. Covers and/or guardrails are required where there are open tanks or vats, including areas where personnel work or walk beneath elevated platforms.
5. Where mechanical handling equipment is used, there must be sufficient safe clearance provided at loading docks, through doorways, and whenever turns or passage must be accomplished. Special concerns should be considered to allow sufficient width for foot traffic, in addition to the equipment.
6. Mark aisles permanently so that employees will be encouraged to keep them clear of obstructions.
7. Special precautions must be taken to make sure that elevated platforms in storage areas are not overloaded. The load capacity should be determined by an engineer, and signs should be posted indicating weight limitations.
8. There should be a routine maintenance program designed for portable

ladders so that unsafe ladders cannot be used. Employees should be instructed and encouraged to report all unsafe ladders.

a. Wooden ladders should not be painted. They should be coated with a clear preservative material so that defects can be easily seen.

b. Wooden ladders should not be stored where they may be exposed to the elements. Storage areas for ladders should have good ventilation.

c. Metal ladders should never be used near energized electrical equipment. They should be clearly marked to prevent such use.

d. Portable straight ladders should always be placed so that the foot of the ladder is positioned one-fourth of the distance away from the vertical plane of the ladder length.

e. Straight ladders should be equipped with safety feet, and employees should be instructed to ensure that ladders are placed on secure footings.

C. MEANS OF EGRESS

(*Reference: E-01 — 1910.35 to 1910.38*)

1. In addition to the normal requirements of exit marking, routes to exits being defined and marked, and the fact that exits should be kept clear of all obstructions at all times, it should be understood that these, as well as all other requirements, are physical items that can be controlled by the employer.

   Employers usually have problems, of varying degrees, in getting employees to do what is required when there is a need to use specific physical items in case of emergencies.

   This appears to be the primary reason for the promulgation of 1910.38 (see page E-03), which requires employers to take certain definitive minimum steps to provide all persons in a plant or establishment with guidance as to how and what to do in case of emergencies.

2. In addition to the basic items required by the standard, you may wish to amplify them in varying degrees depending upon the type of emergency that can be expected. Consider also the potential for a disaster that could be caused by nature, such as tornadoes, hurricanes, floods, etc.

   a. We recommend a written emergency plan, even though the exemption in the standards allows employers with 10 or fewer employees to communicate the plan verbally.

      Our reasoning for the small employer to have the plan in writing is because there is a tendency on the part of most people to forget what is required, especially if they are only required to do "something" in the case of an emergency, which, of course, may *never* occur.

   b. The plan should be as explicit as possible, detailing employees who have been selected to remain behind after the emergency starts, to care for essential plant operations until their evacuation becomes absolutely necessary.

      (1) These essential operations may include the monitoring of power supplies, water supplies, and other items that cannot be shut down for every emergency alarm.

      (2) These monitoring operations are specifically required for chemical or manufacturing which must be shut down in stages, or steps, so as not to create a hazard in and of themselves.

      (3) The use of floor plans or workplace maps which clearly show the emergency escape routes should be included in the plan. Color-coding of these routes will assist the employees in the evacuation process.

(4) The plan should include assigning first aid and rescue duties to a designated person.

(5) All employees should be informed of the actions they are to take in an emergency situation.

(6) At the time of an emergency, employees should know what type of evacuation is necessary and their individual role in carrying out the plan. In some cases, where the emergency is very grave, total and immediate evacuation is necessary. In other cases, a partial evacuation of nonessential employees with a delayed evacuation of others may be necessary for continued plant operations.

In some cases, only those employees in the immediate area may be expected to evacuate or move to a safe area, such as when a local application fire suppression system discharge alarm is activated or sounded.

It is extremely important that employees know what is expected of them in all such emergency possibilities.

(7) The designation of refuge or safe areas for evacuation should be determined and identified in the plan. Where buildings have fire walls, the area may be in the same building, but in a different area where the emergency is located.

Exterior refuge or safe areas may include parking lots, open fields, or streets which are located a sufficient distance from the plant.

The plan should indicate that employees must move away from the exit discharge doors of the building and to avoid congregating close to the building which could hamper emergency operations.

(8) There should be a sufficient number of wardens appointed who are to provide guidance to other employees in the evacuation plan. These wardens should be adequately trained in the plant layout and the various escape routes available. These wardens, and other employees, should provide guidance to any handicapped employees in the work force.

(9) If there are several employers in one building, they are encouraged to consolidate the evacuation plan from the building. Such a building-wide plan is acceptable, provided that the respective employers inform their employees of their individual responsibilities in the plan.

D. PERSONAL PROTECTIVE EQUIPMENT

(*Reference: I-01 — 1910.132 to 1910.136*)

1. The referenced standard has detailed requirements as to when Personal Protective Equipment (PPE) is required in the day-to-day operations. However, the attitude of some employees regarding the wearing of PPE leaves a lot to be desired.

   Unless management takes a firm stand on the use of PPE by employees when required, good PPE programs cannot be maintained. Management may initiate a program that requires the posting of such signs as "Eye Hazardous Area — Eye Protection Must be Worn" or "Hard Hats Required," but, if there is no routine enforcement, signs by themselves will be ineffective.

2. The referenced standard requires employers to provide, and employees to use, such PPE that is necessary for the various hazards involved in the work processes. Such equipment includes protection for the eyes, face, head, and extremities, protective clothing, respiratory devices, and protective shields and barriers, if necessary.

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3. All PPE equipment must be maintained in sanitary and reliable condition whenever necessary by reason of the hazards or the processes involved.
4. If employees use their own equipment, the employer is responsible for ensuring that they are satisfactorily maintained.
5. Community goggles should never be permitted.
6. In the miscellaneous chemical industry, there usually are processes that require the engineering out of hazardous vapors or mists. If this cannot be accomplished, then it is necessary to provide PPE to employees exposed to these vapors. Care must be taken to ensure that the correct respiratory devices are provided.
7. All respiratory protectors must be NIOSH approved, and selection should be in accordance with ANSI standard practice for respiratory protection, Z88.2-1969.
8. Safety equipment manufacturers or suppliers can give guidance on the types of equipment needed in a given situation. They are also in the position to provide recommendations on the cleaning and sterilization of equipment.

E. NOISE EXPOSURE

(*Reference: G-08 — 1910.95*)

OSHA published the final noise standard on March 8, 1983, with an effective date of April 7, 1983. A revised self-inspection checklist was published in the July edition of this Manual. Employers should carefully implement the checklist as soon as possible.

1. If it is not possible to hear and understand a shouting, face-to-face conversation at a distance of two feet, it will be necessary for noise measurements to be taken to determine what further steps will be required.
2. If you are equipped to make the measurements that are required, you should obtain the services of an industrial hygienist to assist in the proper procedures to take so that you can comply with the standards.

F. HAZARDOUS MATERIALS

(*Reference: H-01 — 1910.101 to 1910.111*)

In miscellaneous chemical product manufacturing, employees may be exposed to various toxic hazardous substances. Due to the large number of substances involved, it is impossible to list all chemicals and their related hazards. However, management is responsible for identifying the chemicals used within its respective work processes, and should require Material Safety Data Sheets (MSDS) from the supplier and/or the manufacturer in order to make a proper determination of how to protect employees.

The pyrotechnic and fireworks industry has many safety and health hazards caused by black powder that is used for propellants, bursting charges, and primary mixtures. Other basic materials may incude: combustibles, such as resins, gums, shellac, sulfer, and flake aluminum; oxidizing materials, such as potassium chlorate and barium chlorate; flame-tinting material, such as barium carbonate, sodium oxalate, and paris green; and inert materials, such as paraffin and lime.

The potential health and safety hazards are often aggravated by careless handling and storage and improper operating procedures. Since fire and explosions are the primary dangers, plant managers and supervisors should be reminded that the self-inspection checklist starting on page H-41 of the *OSHA Reference Manual* contains standards that are required to be complied with in the mixing, using, storing, and handling of the ingredients in the manufacturing processes.

The hazards caused by the use of oxidizing materials in liquid and vapor form can cause skin burns, and can be extremely irritating to the eyes, mucous membranes, and the respiratory tract.

In addition to the health hazards, oxidizing substances create a safety hazard because of their potential to ignite combustible

materials. The peroxides of potassium and sodium react vigorously with water and release oxygen and much heat. If combustibles are present when this reaction takes place, fire is likely to occur. Chlorates and inorganic nitrates are strong oxidizing substances that can cause not only fire, but explosion when mixed with finely divided combustible materials, such as floor sweepings.

In the manufacturing of water supply treatment chemicals, the use of very corrosive materials, such as chlorine, diluted hydrazine, ammonia, sodium hydroxide, caustic alkalies, calcium, hydroxide, chromic acid, and sodium hypochlorite, can cause problems in the health of employees due to their highly corrosive nature. Some of these substances are covered by the air contaminant section of standards 1910.1000, page Z-01, and the appendix containing the threshold limits on page Z(a)-02 of the *OSHA Reference Manual.*

Organic chemicals and solvents are used widely in this industry, and are also used for the cleaning of equipment. Most organic solvents have some effect on the central nervous system and the skin. The principal modes of exposure are inhalation of vapors and skin contact. Excessive solvent vapor inhalation may have no immediate discernable permanent effects on health-impairments. An employee may experience drowsiness and lack of coordination that may increase the risk of accidents. In other cases, such as exposure to benzene, it may result in serious damage to bone marrow, blood, lungs, liver, kidney, and the gastrointestinal tract.

There are eight classifications for industrial solvents:

Hydrocarbons: (aromatic and aliphatic): All are flammable. Most have a narcotic effect, and overexposure can lead to loss of muscular coordination, collapse, and unconsciousness.

Halogenated Hydrocarbons: Some may be dangerous to the liver and kidneys in varying degrees.

Alcohols: Generally, their vapors produce mildly toxic effects. Because of their low flash points alcohols constitute a fire hazard.

Ethers: Are highly flammable and possess strong narcotic effects.

Glycol Derivatives: Are flammable, narcotic, and can have a toxic effect on the nervous system and blood.

Esters: May cause irritation of the eyes, nose, and upper respiratory tract. They are also flammable.

Ketones: Are flammable (MEK has a flash point of 21°F), usually are irritants and narcotic. High concentrations can be identified by odor and irritant effect.

Miscellaneous Solvents: Include the nitroparaffins, certain solvents of vegetable origin, and carbon disulfide, one of the most dangerous solvents used in industry. Carbon disulfide, which is highly flammable and highly toxic, can cause permanent damage to the central and peripheral nervous systems. Even the most inert solvents can dissolve the skin's natural protective barriers of fats and oils and leave the skin unprotected and subject to disabling dermatitis, ranging in severity from simple irritation to actual damage to the skin.

Oils and other similar products can clog the skin's pores and cause eruptions if good personal hygiene practices are not followed. Certain oils used in hydraulic fluids may contain organophosphorous compounds that are considered highly toxic when ingested or inhaled.

The preceding portions of this section emphasize the need for management to request MSDS from manufacturers.

In addition to the unique hazardous materials used in the industry, there are the normal materials that are used in all industries that must be controlled.

G. FLAMMABLE AND HAZARDOUS COMBUSTIBLE LIQUIDS

(Reference: H-09 — 1910.106)

1. These may be the materials used in the maintenance department, such as paints and preservatives, which require

roper storage areas, and oxy-fuel gas equipments, welding apparatus, and the like. If these are used, then a control program should be established.

The program should designate storage areas or cabinets for the safe storage of the combustibles. There should be adequate ventilation provided, and self-closing containers for disposal of oily rags, etc.

2. Cabinets for the storage must be properly constructed and have warning signs indicating the contents.
3. No more than one day's supply of combustible liquids should ever be allowed in work areas.
4. If combustible liquids are transferred from one container to another (e.g., from a bulk container to a portable container), the containers must be effectively bonded and grounded.
5. All spills of flammable liquids must be cleaned up promptly.
6. Supplies of flammable and combustible liquids must be stored in approved, fire-resistant safety containers. Flammable liquids should never be left in open containers when not in actual use.
7. Inside storage areas must be prominently posted as "NO SMOKING" areas. Openings to other rooms or buildings must be provided with noncombustible, liquid-tight raised sills at least four inches in height. (For other requirements, please see the self-inspection checklist, page H-18 of the *OSHA Reference Manual.*)
8. General exhaust ventilation must be provided to ensure complete air changes at least six times per hour.
9. Electrical wiring and equipment requirements are also on the self-inspection checklist on page H-18.
10. Outside storage of flammable and combustible liquids should be properly graded and posted with "NO SMOKING" signs. They must also be kept free of weeds, debris, and other combustible materials. Fire extinguishers must be available in the storage area.

H. ADDITIONAL SAFETY PROGRAM NOTES

In addition to the conditions and situations covered above, consideration should be given to the following, since many facilities maintain repair shops with powered equipment and machinery, and have reason to use hand tools and portable power devices. For details, refer to specific OSHA standards already covered in the referenced self-inspection checklists.

1. MACHINE GUARDING

(*Reference: O-01 — 1910.212 to 1910.215*)

Precautions must be taken to ensure that lockout devices and tagout procedures are used when maintenance work is attempted or in progress on machinery.

2. HAND AND PORTABLE POWER TOOLS

(*Reference: P-01 — 1910.242 to 1019.244*)

Take note that the employer is responsible for the safe condition of all tools and equipment used by employees, including those owned or furnished by the workers themselves. Portable electric tools must be double insulated. Check the attached label to make sure this is so. If it is not double insulated, the frame must be grounded.

3. WELDING, CUTTING, AND BRAZING

(*Reference: Q-01 — 1910.252*)

4. ELECTRICAL

(*Reference: S-01 — 1910.302 to 1910.308*)

a. There should be a program established to ensure that exposed wiring, frayed cords, and deteriorated insulation is repaired or replaced as soon as noticed.
b. Covers for junction boxes, outlets, switches, and other fittings should be kept in place at all times, except when being worked on.
c. Grounding connections to fixed equip-

ment should be periodically inspected and/or tested.

d. Flexible cords and cables must be connected to joints or terminal screws in a manner to prevent direct pull on the joints and/or screws.

e. Flexible cords and cables must never be attached permanently to building surfaces or allowed to pass through holes in walls or ceilings.

f. Flexible cords should be of continuous lengths without splicing between connectors.

g. Electrical control boxes/panels and the areas in front of them should have floor markings, so that materials will not be piled or stored in front of them, which would preclude easy access.

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SAFETY PROGRAM FOR GENERAL MANUFACTURING INDUSTRIES

This program outline is a general overview of some of the major problem areas that are usually encountered in manufacturing industries, and should be considered by management in developing a safety and health program.

This outline should be used to generate thoughts and ideas from employer and employee representatives so that the establishment can be made as accident-free as possible.

The safety hazards associated with general manufacturing usually vary in number more than type, depending upon whether the company is engaged in production of complete assemblies or components of products. Most manufacturers have machines such as drill presses, grinders (bench, hand, and table), saws, lathes, etc. These machines present the traditional point-of-operation and electrical hazards, and eye hazards from flying objects. Materials-handling hazards, including those such as cuts, scrapes, and injuries caused by improper lifting, accompany all of the other hazards involved in this industry.

Health hazards will vary in type from company to company for all manufacturing firms. As an example, if your machine operations include the use of cutting and cooling oils, employees may encounter problems with dermatitis.

The guidelines in this program are not intended to be all-encompassing; rather, they are intended to generate thoughts and ideas that can help eliminate hazards and injuries.

A. INTRODUCTION

An effective safety and health program will require the following:

1. A written statement of safety and health objectives and goals;
2. The demonstrated suppport of top-level management and supervisory personnel in the organization's safety and health program;
3. A designation, in writing, of the person who will have the responsibility for implementing the program;
4. The cooperation of all employees in enhancing their safety attitudes, and management's encouragement for employees to provide input to the program.

B. WALKING AND WORKING SURFACES

(Reference: D-01 — 1910.22)

1. All work areas should be kept in a clean and orderly manner. All liquid spills should be cleaned as soon as they occur to prevent slipping.

2. All permanent aisles must be properly marked for easy recognition. Aisles should be kept free of all materials being used. Scrap material should not be permitted to accumulate.
3. Where mechanical materials-handling equipment is used, there must be sufficient clearance in aisles for foot traffic to be accommodated.
4. If employees are required to walk beneath open sides of platforms or similar structures, or where there is a danger of falling materials, tools, etc., guardrails with toeboards should be installed on the platforms.
   a. Standard guardrails should consist of a top rail 42 inches high and a mid-rail halfway between the floor and the top railing. The toeboard should be 4½ inches high with no more than a ¼-inch gap from the floor of the platform.
5. On fixed industrial stairs, the riser and tread width must be uniform throughout any flight of stairs, and all treads must be reasonably slip-resistant.
   a. The minimum permissible width of a stairway is 22 inches, unless it is a path to an exit, in which case it must be at least 28 inches.
   b. If stair treads are less than 9 inches deep, risers should be of the open type.
   c. Vertical clearance to any overhead obstruction should be at least 7 feet, measured from the leading edge of the tread.
   d. For the requirements of standard railings on stairs having four or more risers, then the following apply:
      (1) Railings are required on each open side.
      (2) Stairs less than 44 inches in width with both sides enclosed must be equipped with a hand rail, preferably on the right side descending.
      (3) For stairs greater than 44 inches, railings must be provided on both enclosed sides.
      (4) Stairs greater than 88 inches are required to be equipped with a railing midway between the sides.
      (5) Stair railings must be 30 to 34 inches high.
6. Portable ladders should be inspected frequently and those that are found to have loose joints, improperly attached fitting or hardware that is becoming worn, should be tagged "Dangerous — Do Not Use" and be removed from service until repaired or discarded.
   a. The top step on step ladders must never be used.
   b. Portable straight ladders must be used only when the base is positioned a distance of ¼ the length of the ladder from the vertical plane that the upper end rests against.
7. Fixed ladders must have rungs at least 16 inches in length and with a spacing of no more than 12 inches.
   a. There must be at least a 7-inch toe space in back of ladders.
   b. Vertical ladders exceeding 20 feet in length must have a cage or ladder safety device.
   c. Landing platforms must be available at 20-foot intervals if the ladder is equipped with a safety device, and every 30 feet when equipped with cages.
   d. Side rails must be at least 3½ feet above the landings.

C. EXITS AND EXIT MARKINGS.

(Reference: E-01 — 1910.37)

1. Every door or opening that is intended to be an exit must have an "EXIT" sign in plain, legible letters not less than 6 inches high.
   a. The visibility of the sign must not be impaired by decorations, furnishings or other signs.
   b. All doors, passageways or stairways that are not intended to be used as an exit must have a sign

that indicates their use or must be clearly marked "NOT AN EXIT."

c. Directional arrow signs should be provided where the EXIT is not readily apparent.

d. Exit routes must be arranged so that it is not necessary to travel through any hazardous area to reach the exit.

e. The exit route must lead to a public way. Areas around exit doors must be kept free of all obstructions.

f. Exit doors must swing out in the direction of travel. Doors cannot be locked in such a manner that will impede the exiting traffic.

D. MACHINE-GUARDING

(Reference: 0-01 — 1910.212)

1. All machines must be provided with proper and adequate guards to protect against hazards such as those created by points of operations, in-running nip points, rotating parts, flying chips, sparks, etc.

   a. Care must be exercised to include guarding devices for all such hazards located 7 feet or less from the floor or other working or walking surface.

   b. Guards for machines should be attached firmly to the machine, if possible, or secured elsewhere if the machine configuration prevents attachment. Care should be taken to ensure that the guarding device does not in and of itself create a hazard.

   c. Machines designed for fixed locations must be anchored securely to prevent movement.

   d. The best method for guarding a hazard is by enclosing the operation. If this is not possible, interlocking devices, two-handed trip devices, or automatic guarding may be used.

2. Most machine manufacturers will assist in the development of unique types of guarding.

E. HAND AND PORTABLE POWER TOOLS

(Reference: P-01 — 1910.242)

1. Management is responsible for ensuring that all hand and portable tools are in safe condition. (This includes employee-owned tools.)

2. Mushroomed heads of tools such as hammers, chisels and punches must be ground off periodically to ensure that there is no danger of flying particles.

3. Air pressure used to clean parts or equipment must not be greater than 30 lbs. per square inch (psi). Employees should be cautioned not to use air pressure — at *any* pressure — to clean dust from their clothing.

4. All electric power tools must be equipped with electrical grounding unless the tool is double insulated and labeled as such. Inspection should be made to ensure that the grounding connector on the plug has not been removed or damaged.

5. All hand-held grinders must have proper guards on the wheels unless the operation is such that a guard is impossible to use.

6. Pneumatic power tools should be secured to the air supply hose in such a manner as to prevent accidental disconnecting while in use. Tool retainers must be used to prevent ejection of the tool in use.

F. FLAMMABLE AND COMBUSTIBLE LIQUIDS

(Reference: H-08 — 1910.106)

1. Liquids having a flash point below 100°F are flammable liquids; those with a flash point above 100°F are combustible liquids. All management and employee personnel should understand and be aware of the difference.

2. Containers and piping for both types should be vapor- and liquid-tight.

3. When transferring flammables from one container to another, both must be bonded and grounded to eliminate

the possibility of static build-up. Static sparks will then be eliminated.

4. Spills of both liquid types should be cleaned up immediately upon occurrence. For large spills, clean-up personnel may have to wear protective clothing to guard against the particular hazard involved.
5. Special precautions must be taken to prevent the liquids or their vapors from entering a confined space. A sewer drain is an example of a confined space. If such an incident occurs, special procedures are required.
6. All containers for flammable and combustible liquids should be of approved types that are fire resistant and have self-closing lids.
7. Flammables must be kept in closed containers except when actually in use. Combustible waste materials, such as oily shop and paint rags, must be stored in covered metal containers and disposed of daily.
8. Storage cabinets must be of such a design that they are in compliance with the requirements of the National Fire Protection Association. (See 1910.106(d)(3) on pages H-17 of the *OSHA Manual*.)
9. All storage cabinets must be labeled with appropriate caution signs.
10. Paint-spraying operations are particularly vulnerable to many types of hazards. The most common are improper electrical installations, improper ventilation systems, and improper cleaning ventilation systems.
    a. In order for these hazards to be eliminated, it is advisable to have an electrician inspect the electrical system, to have the ventilation system checked for adequate air flow, and to establish a maintenance program for periodically cleaning the ventilation ducting.
    b. All painting employees must be encouraged (required would even be better) to immediately report any equipment that is operating abnormally. Managers must determine the required amount of paint and/or solvents and insure that these requirements are adhered to by employees.
    c. All spray areas must be kept at least 20 feet away from spark-producing operations, such as welding and burning, or other ignition sources.
    d. If portable paint-drying equipment is used, it must be free of overspray residues. Heat lamps should not be allowed in the booth while spraying operations are in progress.

G. FIRE PROTECTION AND PROCEDURES

(Reference: L-06 — 1910.157)

1. Most plants have the three components necessary for a fire to start:
    a. Fuel, such as gas, packing and cleaning materials, paints and solvents, and trash;
    b. Oxygen, which is a component of air and used in oxy-acetylene processes and;
    c. Ignition sources, such as flames, sparks, heat, hot metals, spontaneous combustibles and electrical equipment.
2. In order to eliminate fire hazards, it will be necessary for managers and supervisors to be constantly on the alert to prevent the combination of these ingredients from forming the "fire triangle."

    Since the oxygen in air is always present, the right combinations of the other two — *fuel* and *ignition* sources — are the ones that are controllable in a plant area.
3. It must be understood, however, that even in the most properly maintained facility, it is always possible for a fire to start. For this reason, management must establish response and evacuation procedures.
    a. Notify the local fire department immediately.
    b. Have several employees in each area of the facility trained in the use of portable fire extinguishers.

c. Post a list of local fire department phone numbers in conspicuous places throughout the plant.

d. Have fire extinguishing equipment as well as fire alarm activators, in strategic places throughout the plant. Exit routes and exits should be properly marked.

e. Have an evacuation plan in case of a *significant* fire.

f. If there is a sprinkler system, ensure that it is in operating condition at all times, through inspection procedures and testing, if required.

4. In addition to the proper placement of fire extinguishers, a periodic inspection is necessary to ensure that they are fully charged , have not been tampered with, and are not corroded or otherwise impaired.

   a. In addition to the above, fire extinguishers must be examined at least annually. Such examinations must be properly recorded and tagged. The examination records are to be maintained for at least one year.

   b. Consideration must be given to the types of hazards that may be encountered when deciding the type of extinguishers to be installed. (Most fire departments are available to render advice, upon request, to ensure that the proper extinguisher is selected.)

   c. It is advisable for tags to be placed on individual extinguishers, indicating the month, day, and year of the examination.

   d. Extinguishers for Class A fires must be within 75 feet of employees. For Class B fires, the distance is 50 feet. For Class C fires, either of the distances for "A" and "B" fires are authorized. For those plants involved in the use of combustible metal (Class D), the distance between the extinguishing agents and employee work areas must be 75 feet.

5. If there is an automatic sprinkler system in the plant, it must meet the design requirements of NFPA 13-1969. If you are in doubt about your existing system, it is recommended that you discuss it with the local fire department inspectors.

6. A common problem associated with sprinkler systems is that employees may pile material too high and, as a result, the required 18-inch clearance between the sprinkler heads is not maintained. This may reduce the protection that the system is designed for, limiting the spray of the water or extinguishing agent.

7. The following are some of the main points to consider when establishing an evacuation plan.

   a. A means of sounding an alarm or other signal.

   b. A well-planned route for personnel in all areas of the plant.

   c. Designated re-assembly areas for personnel well away from the plant.

   d. An accounting (head count) procedure for personnel after re-assembly.

   e. Provisions for ensuring complete evacuation by appointing floor or area wardens so that all areas will be covered.

H. MATERIALS HANDLING AND STORAGE

(Reference: N-01 — 1910.176 to 1910.178)

1. Care must be taken to ensure that the storage of materials does not, of itself, create hazards.

   a. Materials on pallets or in bags, containers, or bundles, must be stored in such a manner that they are stable and cannot collapse.

   b. Stored materials must not block access to fire extinguishers or other fire protection devices, electrical apparatus, emergency lighting, etc.

   c. Material in liquid form must be kept sealed at all times, and if any containers develop leaks, they

must be removed and all hazards created by the leak eliminated.

d. Aisleways must be maintained at all times and have sufficient clearance for foot and vehicular traffic.

2. Powered industrial equipment must be approved for the work area and the environment. The type of powered industrial truck to be used is generally governed by the location in which it is operated. As an example, if the area is such that there is little or no ventilation, you should use an electric truck to avoid the generation of carbon monoxide gas. (Industrial truck manufacturers can give advice as to the type of truck that should be used.)

   The following items should be considered in the operation of trucks.

   a. Operators should be trained in the safe operation of the truck.

   b. Overhead guards should be in place at all times where there is a possibility of materials falling from the load.

   c. When the operator is more than 25 feet away from the vehicle, the forks must be lowered, controls in neutral, power shut off, and the brakes set. (If on an incline, the wheels must be chocked.)

   d. When loads on the fork obstruct the driver's forward view, the truck must travel in the reverse direction.

   e. When handling material to or from trucks, trailers, or railroad cars, provisions must be made to ensure that the unit being loaded or unloaded is secured to prevent its movement by the fork truck. In addition, portable dock boards must be used and secured to prevent movement.

I. WELDING, CUTTING AND BRAZING

(Reference: Q-01 — 1910.252)

1. Oxygen and fuel gas cylinders should always be used or stored in such a manner that they cannot fall over.
2. Cylinder protective caps should be in place except when the cylinders are in use and the gauges are in place.
3. Unauthorized or untrained personnel should never be permitted to use oxy-fuel gas equipment.
4. For cylinders not equipped with a valve-opening wheel, only nonadjustable wrenches should be used, enabling the gas to be shut off rapidly in case of emergency.
5. Combustible liquids and solids must be removed from the area where welding, burning or brazing operations are being conducted.
6. All compressed gas cylinders should be color-coded or marked to indicate their contents.
7. Electric welding areas should be provided with screens or other barriers to prevent welding flashes to nonwelding personnel.
8. To prevent exposure of welding personnel to toxic fumes that may be generated by the welding rod coatings, care must be taken to ensure that there is enough movement of the ambient air; or, as an alternative, employees must be provided with appropriate respiratory protection.
9. All personnel performing cutting with oxy-fuel gas must be cautioned against the use of oxygen as an expedient means of providing ventilation in enclosed or confined spaces. Pure oxygen can easily be ignited by sparks, and in turn can cause the employee's clothing to burst into flames, causing severe injury and/or death.

J. NOISE EXPOSURE

(Reference: G-08 — 1910.95)

1. There is usually some degree of noise associated with this industry, which could cause employees to be exposed to noise levels that exceed the standards.
2. If there are areas in the plant where it is necessary to shout in order to communicate at a distance of 2 feet, there is a distinct possibility that the permissible noise level of 90 dBA is being exceeded.

3. It is generally good practice to have a noise sound level survey made to determine that the employees are protected if the levels exceed the standards. Such a survey should be done by a qualified person.
4. Noise control experts usually recommend that engineering methods be used to eliminate noise hazards. Such engineering controls may include enclosures or change of process methods. If this is not feasible, then administrative controls may be possible by limiting the time for individual employees' exposure. It is possible that hearing protection is the only thing that can be used. In any event, management must take the initiative to protect the hearing of employees, not only because it is the requirement of the standards, but to preclude the possibility of compensation claims.
5. Experts also may recommend initial and annual audiometric examinations of exposed employees.

K. PERSONAL PROTECTIVE EQUIPMENT

(Reference: I-01 — 1910.134 to 1910.137)

1. All employers are required to provide, and employees are required to wear or use, any] necessary personal protective equipment. Such equipment includes protection for eyes, face, head and extremities, protective clothing, respiratory devices, shields and barriers.
   a. All protective equipment, such as respirators, must be maintained in a sanitary and useable condition.
   b. If employees use their own equipment, it is the employer's responsibility to ensure that it is satisfactorily maintained.
   c. Employees involved in eye-hazardous operations must be provided with appropriate protection that meets the standards of the American National Standard for Eye Protection, ANSI Z87-1968.
   d. Community goggles should never be permitted.
   e. If operations are such that the air can be contaminated by hazardous dusts, fumes, mists, gases, smokes, or vapors, employees must be protected by appropriate engineering controls to eliminate the condition, or, as an alternative, be provided with respiratory protection.
      (1) Care must be taken to insure that the proper respiratory cartridge is used; e.g., a dust protective cartridge provides absolutely no protection against mists or vapors.
      (2) Respirators must be of the approved type for the hazards involved.
      (3) Respirators must be NIOSH approved. Selection should be in accordance with the ANSI standard practice for respiratory protection, ANSI Z88.2-1969.
      (4) *Safety equipment manufacturers or suppliers can provide guidance for the type of equipment that should be used.*

L. ELECTRICAL WIRING AND EQUIPMENT INSTALLATIONS

(Reference: S-01 — 1910.302)

1. There should be a procedure developed for ensuring that all exposed wiring, frayed cords and deteriorated insulation is repaired or replaced when noticed.
2. Covers for junction boxes, outlets, switches, and other fittings must be in place at all times, except when they are being repaired.
3. Grounding connections to fixed equipment should be periodically inspected and/or checked.
4. There should be a continuing program to ensure that flexible cords and cables are installed in such a manner that prevents a direct pull on joints or terminal screws.
5. Flexible cords and cables should never be attached to building surfaces or allowed to pass through holes in ceilings or walls.

6. Each circuit breaker should be marked to indicate what equipment it controls. This enables personnel to deactivate the circuits quickly.
7. Before work is begun on electrical circuits, switches must be open, tagged, blocked or locked out. It is suggested that each person authorized to work on circuits have a separate lock to avoid confusion.
8. Passageways to switch centers and electrical control panels should be kept free from obstructions, with not less than a 3-foot clearance.

SAFETY PROGRAM FOR THE FABRICATED METALS INDUSTRY

The following safety program presents an outline of general recommendations based on an overview of some of the major problem areas usually associated with conditions and work practices in metal fabrication operations.

It should be remembered that this is a synopsis of a program. It is not possible to point out all of the possible hazards in any given establishment. This outline is, however, designed to stimulate ideas that will enable you to make use of the applicable portions of the *OSHA Reference Manual*. We recommend that specific details and ideas pertinent to your operations and management be added as a guide to your supervisors and employers.

A. INTRODUCTION

An effective safety and health program will require the following:

1. A *written* statement of objectives and goals.
2. The demonstrated support of top-level management *and* supervisory personnel in the organization's safety program.
3. A *written* program that outlines the broad objectives that will ensure a safe and healthful workplace.
4. A *written* designation of the person who will have responsibility for the program.
5. The cooperation of all employees of the organization and the encouragement of the employees to provide input to the program. Input by employees also will require feedback from management.

B. WALKING AND WORKING SURFACES — GOOD HOUSEKEEPING

(Reference: D-01—1910.22)

1. Good housekeeping is an important element of an effective safety program. While attempting to ensure safe and productive work, management faces many potential problems by not providing good walking and working surfaces.

   If employees are not required to pick up scrap material as work progresses, all safety efforts will go down the proverbial drain.

   We have stated in previous articles of this Manual that a safety inspector, whether a government agent, insurance company representative, or private consultant, relies heavily on his

or her initial observations upon entering the plant. Work areas that are cluttered with scrap or material that is not in use will give the impression that management has no interest in safety and health. As a result, the inspector will look closely at *all* plant operations.

2. The usual method for controlling housekeeping is to have designated areas for scrap and unused materials. This may necessitate a continuing program of informal training on the part of all supervisory personnel to ensure that the program is controlled.

C. EXITS AND EXIT MARKINGS

(Reference: E-01—1910.37)

1. Routes to be used for exits should be clearly defined and marked.
2. All openings that are *not* to be used for exits are required to be so marked. Conversely, all exits are required to have proper exit signs.
3. Exits should be kept clear of all obstructions.
4. There should be at least two exits for each room or space.

D. HAZARDOUS MATERIALS

(Reference: H-01—1910.101 & 1910.102 & 1910.104)

1. Metal fabrication operations usually have some type of hazardous materials on the premises. These may only be the usual oxy-acetelyne equipment, preservatives, and other combustibles. If these are a problem in your establishment, then a control program should be established.
2. Such programs are to include designated storage areas that will prevent fire and safety hazards.
3. Storage areas for combustibles must have adequate ventilation and fire suppression facilities. Combustibles must be placed in self-closing containers.
4. Cabinets containing combustibles must have adequate warning signs indicating their contents.
5. Have a firm and enforced policy on the use and storage of working quantities of combustible liquids. More than one day's supply of combustible liquids should never be allowed in the working areas.
6. Operations requiring spray painting should be performed in a booth to eliminate hazardous vapors from being released into other work areas.
7. "No Smoking" signs should be conspicuously posted.
8. Spray booth exhaust ducts should have a scheduled and documented cleaning program.
9. All lighting and other electrical equipment must be of the approved type.
10. Drying areas must have adequate ventilation.

E. MACHINE GUARDING

(Reference: 0-01—1910.212 & 1910.215)

1. There should be a scheduled maintenance program established for all machines. The program must include such items as inspection of guarding devices, i.e., rotating shafting, belts and pulleys, grounding of electrical parts, etc.
2. Abrasive wheels should have work rests inspected for proper distance from wheel (not more than 1/8 inch).
3. Side guards on grinders must cover the spindle, nut and flange, and 75% of the wheel diameter.

F. HAND AND PORTABLE POWER TOOLS

(Reference: P-01—1910.242)

1. All such tools, whether employee- or employer-owned, must be routinely inspected to ensure that they are in a safe, operable condition.
2. Mushroomed heads of punches and chisels should be ground off to prevent potential eye injuries from flying particles.
3. Air must never be used to remove dirt and dust from employees' bodies or clothing.

4. Portable grinding machines should have guarding devices at all times, unless the grinding wheel is to be used inside the work itself (i.e., on the interior of small piping, etc.)

G. WELDING, CUTTING AND BRAZING

(Reference: Q-01—1910.252)

1. Oxygen and fuel gas cylinders should always be used or stored so that they cannot fall over.
2. Cylinder protective caps should be in place, except when guages are being used.
3. Only trained or qualified personnel should be permitted to use oxygen and fuel gas equipment.
4. Only nonadjustable wrenches should be used on valve stems not normally equipped with a wheel for rapidly shutting off the oxygen-fuel gas supply in case of emergency.
5. Combustible liquids must be removed from areas where welding, burning, or brazing operations are being performed.
6. Compressed gas cylinders should be color-coded or marked to indicate contents.
7. Screens should be used to protect other employees from exposure to welding flashes.

H. ELECTRICAL WIRING

(Reference: S-01—1910.302)

1. Develop a program for ensuring that exposed wiring, frayed cords, and deteriorated insulation is repaired or replaced immediately.
2. Covers for junction boxes, outlets, switches, and other electrical fittings must be kept in place at all times.
3. Grounding connections to fixed electrical equipment should be periodically inspected.
4. Maintain a continuing program to ensure that flexible cords and cables are installed so that a direct pull on joints or terminal screws is prevented.
5. Flexible cords and cables should never be attached to building surfaces or pass through holes in walls or ceilings.
6. Flexible cords are to be used only when they are of continuous length, with no splicing between connectors.
7. Electrical panel control boxes and the areas in front of them should be sufficiently marked so that they are easily accessible and not blocked by stored materials.
8. Portable electrical tools (whether employer-supplied or employee-owned) must be periodically inspected to ensure that grounding prongs are in place. Double insulated tools are excepted.

I. PERSONAL PROTECTIVE EQUIPMENT

(Reference: I-01—1910.132 to 1910.134 & 1910.136

1. All employers are required to provide, and employees are required to use, personal protective equipment necessary for protection in the work processes. Such equipment includes protection for eyes, face, head and extremities, protective clothing, respiratory devices, and protective shields and barriers, if necessary.
   a. All equipment must be maintained in a sanitary and reliable condition.
   b. If employees use their own equipment, the employer is responsible for ensuring that it is being satisfactorily maintained.
   c. Employees engaged in eye hazardous operations must have appropriate eye protection that meets the standards of the American National Standard for Eye and Face protection, ANSI Z87.1-1968.
   d. Community goggles should not be permitted; workers should be provided with individual sets. Use by others should be permitted only if properly sterilized before use.

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e. If operations are such that the air can be contaminated by hazardous dusts, fogs, fumes, mists, gases, smokes, sprays, or vapors, employees must be protected by appropriate engineering controls to eliminate these conditions. If this is not feasible, employees must be protected by an appropriate respiratory protection program (see page 5-31 in your *OSHA Reference Manual*).

(1) Respirators must be of the appropriate type, i.e., dust protection, vapor protection, etc.

(2) Respirators must be of the approved type for the hazards encountered.

(3) Respirators must be NIOSH-approved. Selection must be in accordance with the American National Standard Practice for Respiratory Protection, Z88.2-1969.

f. Safety equipment manufacturers or suppliers can give guidance on the types of respirators that should be provided and the proper cleaning and sterilization methods that should be used.

J. NOISE EXPOSURE

(Reference: G-08—1910.95)

1. Fabricated metal establishments usually have some degree of noise-generating equipment that could expose employees to noise levels that exceed the establishment standards.

2. In such establishments, it will be necessary to have sound level readings taken to ensure that employees suffer no hearing loss. It is recommended that a qualified person be retained to make a determination of the hazards in order to protect employees. Such precautions should preclude compensation claims, in addition to complying with the OSHA standards.

3. Noise control experts usually recommend that the noise be controlled by engineering methods, such as enclosure of the noise-generating parts, change of processing methods, etc. If this cannot be accomplished, then it will be necessary to administratively control noise by limiting the hours per day that an employee will be exposed to excessive levels, or by providing hearing protectors and requiring that they be worn.

4. Noise control experts may also recommend that audiometric tests be given to all employees on an annual basis.

STEP 6: THE INSPECTION

What can you expect when OSHA compliance officers inspect your plant?

It helps to keep in mind that the compliance officer holds the credentials of a federal law enforcement officer whose duty is to determine whether you comply with the general duty clause of the OSH Act and with those specific regulations that apply to your industry. The officer is a trained professional who has prepared for the inspection of your facility by becoming familiar with:

1) the inspection history of your establishment, if any;
2) the nature of your business;
3) the industrial processes you use and their hazards;
4) and the specific OSHA standards that apply to your industry.

Thus you may expect the officer to know what to look for during the inspection — what hazards your workers face and what you and your employees must do to comply with the agency's regulations governing such things as protective clothing, equipment, and procedures.

Things will go most smoothly if you don't adopt an adversarial attitude. The OSH Act makes it your duty to provide your employees with "a place of employment which (is) free from recognized hazards . . . likely to cause death or serious physical harm." You will demonstrate good faith if you show that you take this duty seriously, not just that you follow those regulations which apply to your industry.

The compliance officer has the right to inspect your facilities without delay and at reasonable times. You have the right to demand that the officer obtain a search warrant, but don't expect to gain much by doing so. The courts grant search warrants as a matter of routine, and the OSH Act gives the Labor Department the wherewithal to make things painful for employers who obstruct the inspection process.

Remember also that, given its tight budget, OSHA operates under established priorities, and if a compliance officer wants to inspect your installation, he or she probably has good reason to do so. OSHA puts top priority on those situations which present imminent danger to employees — that is, those condition which may cause death or serious physical harm. It gives second priority to catastrophes or fatal accidents, and third priority to employee complaints. Fourth priority goes to programmed inspections aimed at specific industries presenting high hazards to life and limb.

This last category is important even though it ranks far down on the list of OSHA's priorities. You may expect OSHA to give you special attention if your plant — or for that matter your industry — shows a high incidence of injury or exposure to toxic substances, or a even high number of previous inspections.

Four steps make up the inspection:

1) An opening conference. The inspector presents his or her OSHA credentials and gives you copies of the OSH Act, if you don't already have one, and of those regulations which apply to your industry. During this conference the officerinforms you what has prompted the inspection and how extensive the inspection will be.

2) A records review. The compliance officer reviews all of your written records, including all Log and Summary records (OSHA Form 200), all Supplementary Records (OSHA Form 100), and all other records required by OSHA. (See the red tab section "Written Records," pp. 2-1 to 2-30 in this Manual.)

3) The physical inspection. The compliance officer conducts a detailed physical inspection of your plant.

4) The closing conference. The officer conducts a closing interview in the presence of the employer and the employee representative. During this conference the officer details all unsafe or unhealthful conditions observed during the inspection.

THE OPENING CONFERENCE

The compliance officer will show you credentials and, if the inspection has been prompted by a specific complaint, give you a copy of the complaint. The officer explains the purpose of the visit, the scope of the inspection, and the standards that apply. He or she will ask you to select an employer representative to tag along during the inspection.

An employee representative goes along, too, but you don't get to choose who will serve as employee representative. In union shops, the union agent generally makes the choice. In non-union shops, if your facility has a plant safety committee, the members of the committee make the choice. Otherwise the employees themselves choose, or the compliance officer does. Under no circumstances does the employer choose.

THE REVIEW OF RECORDS

Whether the compliance officer decides to conduct a comprehensive inspection or not mainly depends on the records review. If your records show a high incidence of occupational illnesses or injuries, you can bet that the inspection will be comprehensive. Ditto if your records look sloppy. OSHA treats record keeping as a very serious matter.

Specifically, the compliance officer uses your OSHA Form 200, which logs occupational injuries and illnesses, to calculate a lost-workday injury rate for your plant. The compliance officer compares this rate with national averages published by the Bureau of Labor Statistics and, if your rate falls below the average, generally opts to do a brief tour of your plant — mostly to determine whether you comply with the OSHA Hazard Communication Standard and to see that you have an effective safety and health management program in place.

If your average exceeds the national figures, on the other hand, the compliance officer will conduct a comprehensive inspection.

THE INSPECTION

The compliance officer begins the inspection after the opening conference, accompanied by your management representative and the employee representative. The compliance officer may inspect the plant thoroughly or only in part, going wherever he or she sees fit, even when the inspection results from a specific complaint, fatality or catastrophe.

Under no circumstances may the officer order a halt to work, order employees to leave an area, or close your operations down. The officer does have the power to warn employees of imminent danger. The employees themselves have limited rights to refuse to work. Federal law permits them to refuse to work if in good faith they believe a worksite unsafe or unhealthful. They may also do so if the worksite poses immediate and grave danger to their health.

The officer may use test equipment and a camera to create a permanent record of the inspection. The officer may interview your employees — in private, if necessary — and observe safety procedures in detail. Federal law protects employees who exercise their rights to a safe and healthy workplace. Employees may complain of unsafe or unhealthful conditions confidentially. Employers may not retaliate against workers who alert compliance officers to unsuspected hazards at any time, even while an inspection is underway.

The officer closely observes health and safety conditions, takes instrument readings, collects air samples, measures noise levels, surveys engineering controls, and monitors employee exposure to toxic fumes, gases and dusts. The officer will take care to interrupt work as little as possible.

You have the right to protect your trade and manufacturing secrets. Inform the officer of any trade or manufacturing process that you consider secret. You may also request that only those employee representatives who have confidential clearance accompany the compliance officer into sensitive areas. Rest assured that the officer will keep such information in strict confidence.

OSHA stresses the importance of posting notices and keeping accurate and full records, so remember at all times to keep up to speed in these areas. OSHA commonly imposes fines reaching to $10,000 for each misrecorded or unreported injury. The Budget Reconciliation Act of 1990 allows the agency to go even higher — to $70,000 per incident — although it rarely does. This makes it essential that you stick your nose into your plant's record keeping; don't let those who oversee it day to day miss a thing, and if anybody has any doubt about a particular injury, record it. (See the red tab section on "Written Notices" in this Manual for a complete discussion of this matter.)

The compliance officer will want to see your records of injuries and illnesses. The officer will check to see whether you have posted the totals from the last page of OSHA Form 200, as required, and the OSHA workplace poster (OSHA 2203), which explains worker safety and health rights. The law requires that you display this poster prominently.

The officer will also want to examine your records of employee exposure to toxic substances and harmful physical agents. The Hazard Communication Standard requires that you:

1) establish a written, comprehensive hazard communication program;
2) label containers of hazardous substances;
3) keep your Material Safety Data Sheets up to date;
4) have an employee training program up and running for those who come into contact with hazardous substances.

The training program requires that you keep a list of hazardous substances on prominent display in all areas where your employees work with these chemicals and that you train your employees thoroughly in safety practices. You must also inform employees of the dangers of their failure to follow established routine in working with the substances.

You will do well to treat these requirements seriously. Make every effort to show the compliance officer that you comply not just with the letter of the law, but with its spirit.

With any luck, the officer won't find any unsafe or unhealthful conditions during the inspection, and everybody can go back to work happy and secure. More likely, the officer will find conditions or processes that need your attention. If you can, jump on those violations that can be corrected immediately. The compliance officer will make note of your doing so and will use your willingness to act as evidence of your good faith in complying with OSHA regulations. This is important. Even if you make the correction, however, the officer may use the violation as the basis for a citation and, if appropriate, a proposed penalty.

THE CLOSING CONFERENCE

The closing conference follows the inspection. The compliance officer sits down with you and, usually, your employee representative. (The officer may meet separately, in private, with the employee representative.) The officer will give you a copy of the OSHA publication, "Employer Rights and Responsibilities Following an OSHA Inspection," and discuss its details briefly. The publication does not constitute your Miranda rights, but be careful of what you say. The officer expects a frank and open discussion of whatever the inspection has uncovered. You, however, must keep in mind that, if push comes to shove, the officer may use whatever you say against you.

This discussion covers all unsafe or unhealthful conditions observed during the inspection. The officer discusses each in turn and indicates which violations call for a citation and/or a penalty, although he or she will not disclose just what the penalty might come to. Remember that citations aren't automatic; neither are penalties. The officer will tell you what conditions may result in a citation and/or penalty, but the actual decision to issue a citation or propose a penalty lies farther up the chain of command, with the officer's superiors.

Present your case openly during this conference. Produce whatever records you have to substantiate your position, especially those which show your efforts to comply with OSHA regulations. Let the compliance officer know how much time and money you think it will take to correct any problems uncovered during the inspection. If you need it, ask for a second closing conference; you will want one especially when you must evaluate health hazards, possibly using lab reports that take time to get.

In addition, query the compliance officer as to the resources available to employers through OSHA. The agency's offices inform the public as to their health and safety activities and new or revised standards. They also provide technical assistance and materials, including courses offered through the OSHA Training Institute. They promote safety and health through voluntary protection programs and employer abatement assistance efforts. If any of these services apply to your plant, make use of them.

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STEP 7: CITATIONS, PENALTIES AND IMMINENT DANGER

With any luck the OSHA compliance officer will have inspected your plant and discovered nothing wrong, and you and your employees can go about your business without further ado.

But don't count on it. The greater likelihood is that the inspection will result in citations and/or penalties. How does OSHA view violations? What's an "other-than-serious" violation? What's the difference between a "willful" and a "serious" violation? What about repeated violations? What does OSHA do about conditions of imminent danger? How badly may the agency hurt you with penalties? What does it require you to do if it issues citations?

CITATIONS

You already know which conditions or procedures worry the compliance officer who inspected your facility; you discussed them with the officer during the closing conference following the inspection. The discussion also covered your options for abating the conditions and the possible dates by which OSHA may require that you act.

In essence, then, the citations put in writing what you already know, so they should come as no surprise. This doesn't make your receipt of the citations any more enjoyable, of course.

The OSH Act, however, does not permit that you go about correcting unsafe or unhealthful conditions lackadaisically. It sorts violations into three main categories, the other-than-serious, the willful and the serious.

1) It defines an other-than-serious violation as one having a direct impact on job safety or health but probably posing no threat of death or serious physical harm.
2) It defines a willful violation as an unsafe or unhealthful condition about which the employer knew and made no reasonable effort to eliminate it.
3) It defines a serious violation as one which could cause an accident or illness that would most likely result in death or serious physical harm.

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The Million Dollar Club

The agency also makes use of the term "egregious" without formally categorizing such violations. In practice the agency uses the phrase to describe those violations, often resulting in fatalities, in which employers show wanton, blatant disregard for the health and safety of workers. OSHA issued its first "egregious" citation in 1986, and in the next five years it issued another 100-plus (out of some 300,000 cases overall).

This is one club you don't want to join. Fines in such cases easily hit $1 million or more, and employers who incur them also face the threat of doing jail time. This threat probably serves as a greater deterrent than even a $1 million fine. Corporate leaders who write big checks to OSHA answer only to their boards of directors and stockholders. They have other, more dangerous people to worry about if they go to jail. In fact OSHA rarely seeks to send employers to jail, but as time passes the practice becomes more common.

Repeated Violations

The agency may issue a citation for repeated violations in any of these categories. Citations for repeated violations go to employers previously cited for substantially similar conditions. As a rule such citations issue when the repeated violation occurs within three years of the original citation.

OSHA requires that you post copies of any citations you receive at or near the location where the violation occurred. Thus a citation covering improper hazardous materials handling must go up at the location in your plant where the compliance officer found the violation — and not in some little-used stairwell, for instance. The point is obvious: OSHA wants your employees, whose safety and health the agency seeks to protect, to know that you have been cited, and why. You must keep the copies of the citations posted until you have corrected the condition, or for at least three days. Weekends and holidays don't count. You must comply with this posting requirement even if you contest the citation.

IMMINENT DANGER

The compliance officer has no power to halt work in your plant or to order your employees to leave an area where they face imminent danger — but this doesn't mean that the latter, at any rate, won't happen anyway where imminent danger exists.

OSHA defines imminent danger as "any conditions or practices in any place of employment which are such that a danger exists which could reasonably be expected to cause death or serious physical harm immediately or before the imminence of such danger can be eliminated through the enforcement procedures otherwise provided by (the OSH) Act."

The short way of saying the same thing is that if the compliance officer comes across something that, in his or her opinion, threatens life and limb, you're in trouble. The officer must determine with reasonable certainty that death or serious physical harm will occur within a short period of time — specifically, before OSHA's normal abatement procedures could be brought to bear.

Warning to Employees

In such circumstances you can expect the officer to warn your employees of the danger right away. You can also expect your workers to abandon their work stations if in good faith they believe themselves in immediate and grave danger. Federal law protects them if they do so, although the sanction does not constitute blanket protection. Under some circumstances your workers will find additional protection under the National Labor Relations Act.

Thus, although the compliance office holds no power to put a stop to your operations, in practice, work will probably come to a halt anyway where conditions of imminent danger exist. And you can expect OSHA to get the blessing of the federal courts in short order, in the form of a cease and desist order. The compliance officer informs his or her superiors in the agency who, in turn, petition for a restraining order in U.S. District Court. They waste no time doing so, either. OSHA gives first priority to such litigation so as to head off the threat that workers will come to harm.

PENALTIES

The compliance officer will have already given you some idea what sort of fines to expect from the violations uncovered during the inspection. OSHA gives formal notice of the fines it contemplates in the citations themselves. It never comes as good news.

The Omnibus Budget Reconciliation Act of 1990 gave OSHA authority to increase its fines sevenfold. The agency may fine you up to $7,000 for other-than-serious and serious violations, and up to $70,000 for willful violations.

OSHA may also cite you for failing to correct a violation for which you have been previously cited — and fine you up to $7,000 per day for as long as the hazard persists unabated. It may fine you up to $70,000 for repeated violations. It may fine you up to $70,000 for making false statements or for interfering (or even for threatening to interfere) with the inspection. It may fine you $70,000 for falsifying your records, and $7,000 for violating the agency's posting requirements.

Presenting the Bill

The citations you receive from OSHA list the fines which the agency proposes to levy against your organization. Since compliance officers rarely uncover only one or two violations, these penalties assume frightening proportions very quickly.

Keep in mind, however, that OSHA levies fines to its greatest authority only rarely. Compliance, after all, is a delicate thing. OSHA wants employers to make the workplace safe and healthful. It doesn't want to force employers up against the wall, or to bludgeon them so violently as to give them no alternative to resisting the agency tooth and nail. The Congressional writers of the 1990 budget act had a massive deficit to paper over. They frankly increased OSHA's authority to levy fines in an attempt to convince people that doing so would actually increase revenue. Nothing of the sort occurred, of course.

Instead, OSHA's leaders take the position that the agency exists to enforce compliance with health and safety regulations, not to produce revenue for the Federal Government. So they use their authority to fine employers with discretion, and although almost any OSHA fine looks imposing to employers — especially to small employers whose resources don't permit them to mount thoroughgoing safety programs — rest assured that OSHA won't try to pay off the national debt by raiding only your bank account.

Four Factors

OSHA sets fines in accordance with four factors:

1) The gravity of the violation;
2) The size of your business;
3) Your good faith;
4) Your history of violations.

Of the four, you have the chance, at this point, to do something only about good faith. OSHA takes your awareness of the OSH Act as evidence of your good faith — and takes items like your safety and health programs as evidence of your awareness of the act. To put it simply, you will demonstrate your good faith if you can show that your health and safety programs work effectively and that you devote serious attention to them. Among small employers who don't maintain formal health and safety programs, OSHA wants to see worksite evidence of safety consciousness. In other words, show the compliance officer that you require your workers to observe common safety practices.

As mentioned earlier, OSHA also likes to see an employer jump on health and safety hazards uncovered by the compliance officer. Whenever possible, take corrective action immediately — while the compliance officer is on your premises, if you can.

Once you have been cited, you may either pay the penalty (generally within 15 days) and agree to correct the condition by the date set in the citation, or you can contest the whole thing. The procedures for contesting citations are complex and fraught with dangers to the employer. For a detailed discussion, see the blue tab section "Legal Considerations of OSHA" in this Manual.

THE INFORMAL CONFERENCE

Whether you comply or contest, you have the right to seek an informal conference with OSHA's area director to discuss any issues related to the citation and the proposed penalties. OSHA sees this informal conference as your opportunity to discuss the problems you foresee in complying with the OSHA citation. You may see in the informal conference a different opportunity — namely the chance to negotiate a settlement.

Come prepared. If you consider it impossible to comply fully with the citation, present your facts and marshal your arguments. Detail what you must do to meet OSHA's demands — dollars, time, effort. Present a realistic schedule for completing the work involved in correcting the violations. Outline the special problems you may have in instituting disciplined employee safety practices. Propose some alternative ways to correct violations.

In all of this, keep uppermost in mind that your object is to satisfy OSHA that you will properly improve health and safety conditions at your plant on terms with which you, in turn, can live.

The Option to Comply

If you choose to comply, you must inform the area director in writing exactly what corrective actions you propose to take and when. (You must also pay the penalties, of course.) The law requires that you adequately protect your workers while you correct any unsafe or unhealthful conditions.

This becomes especially important when OSHA has given you an extended period of time to institute the corrective measures. Under such circumstances you must keep the area director informed of your progress; you must also detail, in writing, exactly how you provide your workers with special protection in the interim.

If, for example your plan of corrective action entails substantial re-engineering of your worksite — a time-consuming task — you may have to provide your workers with protective clothing or equipment while the new engineering controls go into place. OSHA wants to know about all of this. It also wants to know how things progress. Keep the agency informed with regular progress reports. When you have completed the entire process, make sure that everybody knows what you have done.

POST THE FOLLOWING NOTICE ALONG WITH A COPY
OF THE VARIANCE APPLICATION IN A
PROMINENT PLACE FREQUENTED BY EMPLOYEES

TO ALL EMPLOYEES

This is a copy of the variance application submitted by XYZ Company for a variance from OSHA Standard 1910.179 (b) 4, concerning the wind indicator on the outdoor bridge of a Gantry Crane. As an employee of the XYZ Company, you have the right to request a hearing with the Assistant Secretary for Occupational Safety and Health, U.S. Department of Labor, according to Standard 1905.15, Request for Hearing, if you object to the variance requested. You may also submit comments on the variance application. These requests must be filed in writing, and submitted in quadruplicate to the Assistant Secretary for Occupational Safety and Health, Department of Labor, Washington, DC, 20210.

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The agency usually makes a final decision on applications for variances within 120 days. This, of course, allows time for publication in the Federal Register and, if necessary, a public hearing.

PERMANENT VARIANCES

You may obtain a permanent variance if you can demonstrate that your practices exceed the requirements of a given health or safety standard. Once again, the burden of proof lies on your shoulders, and OSHA doesn't make it easy.

Your application must present:

1) The employer's name and address, and the address of the worksite;
2) The specific standards from which you seek a variance;
3) A detailed description of how you have informed your employees of your intention to seek a variance — specifically, where you have posted a summary of your application for a variance, where your employees may review a copy of the application itself, and how you have informed them of their worker rights;
4) A request for an interim order or for a hearing, if desired;
5) A list of the measures you take to protect your employees and a full explanation of why you believe your practices exceed OSHA's requirements;

File an original and six copies with the Assistant Secretary for Occupational Health and Safety, Department of Labor, Washington, DC 20210. If your application involves worksites in more than one state, and if one of those states runs an OSHA-approved state plan, you may choose to file with the state only.

In deliberating on your request, OSHA reviews your plant's inspection history and, as it does with temporary variances, sends a variance officer to the worksite to gather first-hand evidence.

Once again, the agency encourages input from workers and unions. It publishes a notice of your application in the Federal Register and may schedule a public hearing as well.

The agency's formal approval of your application details the specific responsibilities you undertake to assure worker safety and health. It also explains exactly how your practices differ from the requirements of the standard.

OSHA uses no standard form for applications for either temporary or permanent variances. A model application follows at the end of this section of the OSHA Manual.

MODEL VARIANCE APPLICATION

(for illustrative purposes)

XYZ Company

Date

Assistant Secretary for Occupational Safety and Health
U.S. Department of Labor
Washington, DC 20210

Dear Sir:

Type of variance — Standards affected

Pursuant to Section 6 (d) of the Williams-Steiger Occupational Safety and Health Act of 1970 (84 Stat. 1596: 29 USC .655), XYZ Company respectfully requests a permanent variance from the requirements of 29 C.F.R. 1910.179 (b) (4), concerning wind indicator on the outdoor bridge of a Gantry Crane.

Applicant
Place of employment —

Company information — Description of circumstances and why variance is necessary — How employees will be protected by proposed practices

XYZ Company has a Gantry Crane which operates beside a slip for unloading shallow draft barges. It currently is used only for unloading salt barges, usually about twice a year. Because of the location of our operation and the experience we have had with high wind conditions, XYZ Company recognizes the importance for monitoring wind conditions. As a result, our plant has two wind indicating devices with visual and automatic recording devices. We have a well established plan for monitoring Federal Weather Bureau reports and emergency plans of action for pending high winds. The key wind indicating device is located in the Shift Superintendent's office. A Shift Superintendent is on duty around the clock, seven days a week and is responsible for the plant. He keeps a close watch on the wind conditions and also monitors weather forecasts at least three times during each eight-hour period. A written record is kept of the weather conditions.If there are any changes in wind conditions or anticipated changes due to approaching bad weather, the wind indicators and weather forecast are monitored continuously. Because of these well established policies and the limited use of the Gantry, we feel that our plan would offer a safer operation. In addition, we feel that the installation of a wind indicating device on the Gantry Crane would not be feasible because of conditions which tend to cause malfunction. Our past experience has verified this consistently. The Gantry Crane is very close to the molten sulfur pits and salt water. The close proximity to these agents creates a corrosive condition which would make the wind indicator inoperative soon after installation. We feel our monitoring and early warning system is more effective and safe than is the use of an infrequently used and difficult to maintain wind velocity instrument on the crane.

Due to the corrosive conditions present around the Gantry Crane, XYZ Company feels that our established procedures would give more reliable information than an indicator on the crane. Therefore, we feel that this would ensure the safety of the crane and operator.

Respectfully submitted,

_____

Manager

Request for interim order, if desired

XYZ Company also respectfully requests that an interim order be granted to allow operation of the Gantry Crane without the indicator until action is taken on the variance application. We feel that the safety of the employees will be guaranteed because we do have wind indicators being monitored at our plant and the Gantry operator would be promptly informed before wind velocities rose or approached a dangerous level.

_____

Manager

Verification that employees have been notified of the variance application and their rights to comment and/or request a hearing

This is to certify that a copy of the variance from Standard 1910.179 (b) 4 requested by XYZ Company has been posted in an appropriate place for employees to examine. Also, an explanation of their right to send comments or petition for a hearing are explained on an attached sheet. A copy of the variance application was also given to the authorized employee representative.

Posted on _____, 19

_____

Manager

STEP 8: VARIANCES

You may find it impossible to comply with new OSHA health and safety standards for reasons wholly beyond your control. OSHA grants temporary variances from the requirements of its standards under special circumstances. The agency grants permanent variances when you can show that your established practices go beyond what a given health or safety standard requires.

How do you obtain temporary or permanent variances? What do you have to show to persuade OSHA that you can't meet the agency's deadline or that your practices exceed the requirements of a given standard?

As you might expect, OSHA doesn't exactly make it easy to obtain variances. If you need a temporary variance, you must document the circumstances which make it impossible for you to meet the agency's compliance deadline. If you want a permanent variance, you must describe in detail exactly how your own practices go beyond OSHA's requirements in protecting worker health and safety.

In either case, OSHA grants variances only if you present convincing evidence.

TEMPORARY VARIANCES

OSHA issues all new health and safety standards with effective dates — that is, with deadlines by which you must comply. The agency takes these deadlines seriously, but sometimes you can't meet them.

OSHA grants temporary variances when you can show that:

1) You cannot complete the necessary work to install engineering controls on time;
2) You can't get professional help needed to design or complete the necessary construction;
3) You can't get the materials you need.

OSHA issues temporary variances for one year at the most. It renews temporary variances for six months — but only twice. Thus no matter what difficulties you face in meeting the standard, you cannot get a temporary variance from OSHA for more than two years.

The agency stresses the importance of informing employees about your application for a variance. Federal law gives workers the right to request a hearing on your application for a variance; indeed, OSHA encourages workers and their unions, if present, to take part in the process. To this end, the agency goes so far as to publish notices in the Federal Register of all applications for variances, despite the fact that it knows full well that most workers don't spend much of their free time reading that publication.

Your application for a temporary notice must certify that you have informed your workers of your application, that you have given copies of all applications to a union or other employee representative, and that you have posted a summary of your application wherever you customarily post notices in the workplace.

As if that weren't enough, OSHA also requires that you inform your workers of their right to involve themselves in the variance process — specifically of their right to request a hearing on the matter.

The Details

Your application for a temporary variance must include the following information:

1) The employer's name and address, and the address of the worksite;
2) The specific standards from which you seek the variance, cited by number;
3) A detailed description of how you have informed your employees of your intention to seek a variance — specifically, where you have posted a summary of your application for a variance, where your employees may review a copy of the application itself, and how you have informed them of their worker rights;
4) A request for an interim order or for a hearing, if desired;
5) A full explanation of why you cannot comply by the effective date;
6) A list of the measures you employ in the meantime to protect your employees until you can achieve full compliance;
7) The date by which you expect to achieve full compliance;
8) A description of the process you will undertake to achieve full compliance.

OSHA does not require that you get all this down on a single page.

The agency requires that you submit an original and six — count 'em, six — copies of your application to the office of the Assistant Secretary for Occupational Safety and Health, Department of Labor, Washington, DC 20210. If the variance applies to worksites in more than one state, and if one of those states operates an OSHA-approved state plan, then you don't have to file the application with both the federal and state agency. You get to choose to file it with one or the other.

OSHA sends a variance officer on a inspection of the worksite for a first-hand look at your practices and at the difficulties you face in meeting the compliance deadline. Normally you will hear of this visit before it takes place.

STEP 9: SBA LOANS

The Occupational Safety and Health Act of 1970 affects small businesses as well as large. The Act can make it necessary for businesses to add to or alter their equipment, facilities, or methods of operation in order to come into compliance with the Act's standards. However, the Act is not intended to cause economic harm to small businesses in such situations. To meet just such a problem, Section 28 of the Occupational Safety and Health Act amends the Small Business Act. The amendment authorizes the Small Business Administration (SBA) to make loans to assist businesses to meet the standards of OSHA or state laws. Such help is made available if SBA determines that the business is likely to suffer substantial economic injury without assistance.

WHO IS ELIGIBLE

The OSHA law says that any small business "likely to suffer substantial economic injury" without such assistance as it seeks in order to comply can be eligible for an SBA loan. For employers to qualify for assistance, they must: satisfy SBA size requirements, which *generally* are as follows:

> *Manufacturing*—average employment in the preceding four calendar quarters did not exceed 250, including employees of any affiliates. If employment exceeded 250 but not 1,500, SBA bases its determination on a specific size standard for the particular industry.
>
> *Wholesaling*—yearly sales are not over $5 million to $15 million, depending on the industry.
>
> *Retailing and Service*—annual sales or receipts are not over $1 million to $5 million, depending on the industry.

In essence, the applicant must be an independently owned or operated small business not dominant in its field.

WHAT THE LOAN MAY BE USED FOR

An employer may use the proceeds of the loan to construct a new building, even in a new location, to replace an old building where remodeling is not feasible, or to replace rented quarters when needed upgrading cannot be arranged.

Bank loans may be refunded when the terms of such loans (intended for permanent financing) prove too burdensome for the borrower and the

bank itself requests refunding because it realizes a longer term will benefit the borrower. The loan may not be used to effect a take-out from a possible loss.

Bank loans also may be refunded when they are rushed through for short term improvements to meet compliance requirements. A loan may be used to replace working capital expended for compliance, such as meeting construction time limits. It also may be used, when construction is involved and operations are curtailed, to meet continuing fixed costs such as payment on equipment notes and mortgages, to help finance startup costs, and to finance operating changes required to come into compliance.

WHEN TO APPLY

An employer may make application for a loan under one of two procedures: (1) before he has been inspected, in order to come into compliance, or (2) after he has been inspected, to correct alleged violations.

Before Inspection: When an employer has not been inspected by OSHA and requests a loan to bring his establishment into compliance before he is inspected, he must submit the following to SBA:

a statement of the conditions to be corrected.

a reference to the OSHA standards that require correction

a statement of his financial condition that necessitates applying for a loan

He should obtain from a licensed professional engineer and/or architect a report on the work to be done. This report should cite existing conditions, the standards that require the work, and plans and specifications of sufficient clarity to permit OSHA to determine that the work will bring the establishment into compliance.

He should submit to SBA a copy of this report, along with any background material. The SBA will then refer the application to the appropriate OSHA Regional Office, Office of Technical Support.

The OSHA Regional Office will review the application and advise SBA whether the employer is required to correct the described conditions in order to come into compliance, and whether his proposed use of funds will accomplish needed corrections.

Direct contact with the applicant will be initiated by OSHA only after clearance with SBA, and will not be conducted at the applicant's establishment.

The appropriate SBA field office will review the applicant's financial statements to determine his ability to meet repayment terms and will then process the application to a conclusion.

After Inspection: The procedure is the same as before inspection, except that the applicant also must furnish SBA a copy of the OSHA citation(s).

SBA then refers the application to the OSHA Area Office that performed the inspection. That office will notify SBA as to whether or not the proposed use of loan funds will adequately correct cited violations.

Submission of a loan application in no way affects the abatement period prescribed for the cited violations. A request for extension of the abatement period should be filed immediately, stating that time is needed to plan and finance work to correct violations, in accordance with normal procedures.

When OSHA has cited an establishment for alleged violations and the employer contests the citation, neither OSHA nor SBA will take any action until the contest process has been completed and the Occupational Safety and Health Review Commission has issued a final order.

WHERE TO GET THE LOAN

The SBA will make loans in cooperation with banks or other lending institutions or on a direct basis.

WHAT COLLATERAL IS NECESSARY

The applicant must be in sound financial condition, and there must be reasonable assurance that the loan will be repaid. The applicant must pledge whatever collateral or give whatever guarantees he can. When the SBA loan is used to acquire fixed assets, these must be pledged as security.

Personal and/or business assets will be used to the greatest extent possible, but it is not expected that they will be needed to the point of curtailing working capital or reserve requirements.

LOAN MATURITY

Loan maturity is based on the applicant's need and earnings, but repayment must be made at the earliest possible date. The maximum term is thirty (30) years.

INTEREST AND FEES

Within certain limitations, the private lender sets the interest rate on guaranteed loans and on its portion of immediate participation loans.

Interest rates on SBA's portion of immediate participation, as well as direct loans, may be obtained from any SBA office, since the rate is subject to change, depending on the average annual interest rate on all interest-bearing obligations of the United States.

APPLICATION FORMS *

Forms for loan applications can be obtained from any SBA field office. In some instances, private lending institutions will be able to provide the forms for SBA bank participation loans.

*Editors note: Congressional budget cuts have left SBA short of funds with the result that SBA is not accepting applications for direct loans, but may, under certain circumstances provide guarantees for loans arranged with commercial lenders. To be safe, consult your banker or the regional SBA office on the current situation. At the time of publication of this notice, there were no available indications as to when the SBA program for OSHA-related loans would be reinstituted. While the legislation for SBA loans is still in place, necessary funds for the budget would have to be replaced for it to be operative.

STEP 10: LEGAL CONSIDERATIONS OF OSHA

NOTE: This guide does not attempt to function as a comprehensive analysis of the Occupational Safety and Health Act. It provides only an overview to the Act. OSHA's influence on American business is so far reaching that a detailed examination of the ACT's provisions and its effects would fill a large volume. Readers should consult with an attorney on specific problems relating to the Act, the Occupational Safety and Health Administration and the Occupational Safety and Health Review Commission.

Every employer must comply with OSHA. The Department of Labor employs hundreds of compliance officers throughout the United States to insure that employers follow the rules, regulations, standards, and the General Duty Clause of OSHA. These OSHA compliance officers will enter your work establishment without a search warrant for the purpose of finding violations of the Act or its standards. OSHA does not give advance notice of safety inspections except under four conditions:

1. When the danger to workers is imminent and apparent.
2. When an after hours inspection will be more productive or when an employer must make special preparations for the inspection.
3. When representatives of either the employer or employees must assist in the inspection.
4. When the Area Director of OSHA feels that advance notice would help the safety inspection process.

Only the Area Director can give advance notice with one exception. Lower ranking Compliance Safety and Health Officers may give notice if the danger to workers is imminent and apparent. Tipsters who otherwise give employers advance notice of an inspection face stiff penalties -- fines up to $1,000 and prison terms to six months. An employer may object to an inspection and thereby limit the areas seen by the Compliance Safety and Health Officer. Objections usually prove futile, since OSHA officials obtain search warrants easily.

When safety inspectors find a violation, they issue a "citation" with a specified abatement date and notification of proposed penalties. The citation becomes final unless contested. Serious violations that remain uncorrected become subject to followup inspections and additional penalties. Contested citations go to hearing before a hearing examiner appointed by the Chairman of the OSHA Review Commission. If an OSHA Hearing Examiner rules in favor of the OSHA Compliance Officer, the employer may appeal to the Review Commission, but only with the Commission's permission. Substantial penalties accrue daily for each indivdual citation or violation under appeal.

NOTICE OF CONTEST

Employers who receive citations and proposed penalties from the Area Director have the right to contest them before the Occupational Safety and Health Review Commission, an administrative agency established by the Act. To contest a citation one must be willing to undergo an exhausting sequence of events. The longer the administrative and judicial review proceedings last, the greater the monetary risk to the employer.

The employer must initiate this procedure with the Area Director within fifteen working days from receipt of the citation. The notice of contest can be a letter or formal legal pleading explaining the employer's reasons. The notice must go **certified mail, return receipt requested** to the Area Director with a copy to union representatives, if any. In non-union shops, service may consist of posting the notice of contest at the same place where OSHA posted the original citation. It should be noted that contesting a citation may trigger an increase in penalties.

The employer must post a notice of contest at each job site where a citation has been served. If the employer has completed work at a site where an alleged violation occurred, the notice of contest goes to the job site where employees report to work each day.

OSHA insists that employers notify employees so as to allow them to identify themselves as parties. Notices should include a warning that any worker who fails to come forward prior to the hearing will not be considered a legitimate participant.

On the following pages are examples of forms for an employer's notice of contest, notice to employees, and certificate of service and posting.

OCCUPATIONAL SAFETY AND HEALTH REVIEW COMMISSION

Secretary of Labor,	:	
Complainant,	:	DOCKET NO._____
vs.	:	
Employer,	:	
Respondent,	:	NOTICE OF CONTEST

Comes now (EMPLOYER), (ADDRESS), hereinafter referred to as "Employer," and files this Notice of Contest to each and every item of the citations and proposed penalties in the Citation (DESCRIBE CITATION). The Employer herein contests each and every item of said Citation and each and every proposed penalty proposed therein. The Employer specifically denies that the Employer has violated the Act as alleged, and the Employer intends to raise any and all legal and factual defenses in any ensuing proceedings.

This_____day of_____, 19__.

(EMPLOYER OR ATTORNEYS)

By_____
(SIGNED)

NOTICE TO EMPLOYEES

The following proceeding is now pending before the Occupational Safety and Health Review Commission, and employees affected and not represented by a certified bargaining representative and who fail to identify themselves as a party by appropriate notice to the Examiner or the Commission prior to the commencement of a hearing shall, except upon order of the Examiner of the Commission, be *estopped* from asserting his party status.

If you wish to appear or be represented in this proceeding, you will be governed by the rules of the Commission, which are published in 29 Code of Federal Regulations, Part 2200, which was published in the Federal Register August 31, 1971, Volume 36, No. 169, pages 17409, *et seq.*

(CITE STYLE OF CASE AND OSHRC DOCKET NUMBER)

CERTIFICATE OF SERVICE AND POSTING

The undersigned certifies that a copy of the foregoing Notice of Contest and the foregoing Notice to Employees have been posted in a conspicuous place where employees can see them at (ADDRESS OF ESTABLISHMENTS WHERE POSTED), and that I have served a copy of the foregoing Notice of Contest on the below listed parties by Certified Mail, Return Receipt Requested, properly addressed and with sufficient postage thereon:

Area Director
Occupational Safety and Health Administration
United States Department of Labor
(ADDRESS)

Occupational Safety and Health Review Commission
1825 K Street, N.W.
Washington, D.C. 20006

NOTE: If the affected employees are represented by an authorized representative the authorized representative must be served by Certified Mail, Return Receipt Requested, and his name and address added to the list in this position.

This_____day of_____, 19__.

(EMPLOYER OR ATTORNEYS)

By_____
(SIGNED)

HEARING

A hearing is scheduled before a Commission Judge after the Area Director receives the notice of contest. Once the employer has filed the notice of contest, any corrective action set forth in the citation is automatically suspended until the Commission Judge's order becomes final. As already noted, the employer risks additional penalties and fines in contesting a citation.

The Secretary of Labor must file the notice of contest and all citations, penalty notices, and failure to correct violations with the Commission Judge within fifteen working days. The Secretary of Labor must file a complaint against the employer within thirty days. The employer and employee representatives also receive copies of the complaint. For non-union workers, the employer must post the complaint in the same manner as the notice of contest.

An employer who receives a complaint **must** file an answer within thirty days. This answer should contain statements of fact and must follow form.

New guidelines in 1986 revised OSHRC rules to streamline proceedings. The employer may elect to remain silent to an allegation without admitting or denying it, but this only delays settlement. Federal law requires the Secretary of Labor to set forth specific allegations against an employer. Employers must be definite in their answers as well.

The Commissioner appoints a Judge to conduct the hearing. The Judge controls all proceedings, discoveries, depositions, and production of documents in the case. Sometimes the Judge conducts a prehearing conference during which the parties clarify the issues, consider the necessity or desirabilty of amending the pleadings, stipulate facts and admissions, authenticate documents, request or object to subpoenas, discuss the use of depositions, disclose the names of the witnesses, synopsize expert testimony, etc.

After the prehearing conference, the judge notifies all parties of the time and place of the hearing itself. The employer must post this notice of hearing. Each party has the right to subpoena witnesses and produce relevant books, records and documents.

A new participant in the OSHRC litigation process is the Settlement Judge. The parties in a litigation may request the Commission to appoint a Settlement Judge. The role of the Settlement Judge is to encourage parties to resolve their disputes. This may include private conferences with each side to discuss settlement possibilities. The mediation attempts of the Settlement Judge may not last longer than 45 days without the approval of all parties.

The Secretary of Labor has the burden of proof for the allegations contained in the citation. At the hearing, each party has the right to cross-examine witnesses and present evidence. The proceedings are recorded, and any interested party may acquire a copy of the transcript for a fee.

The Commission Judge certifies the record of the hearing, and all parties have twenty days to contest findings of fact and conclusions of law. Thereafter the Judge prepares a report and files it with the Executive Secretary of the Commission.

REVIEW BY THE OCCUPATIONAL SAFETY AND HEALTH REVIEW COMMISSION

The Judge's report becomes final unless an employer files a petition for discretionary review. The Occupational Safety and Health Review Commission does not have to review the report, which becomes the final order of the Commission unless a member grants a discretionary review. The Commission may specify whether it desires oral argument or the filing of supplemental briefs. The parties in the dispute do not have the automatic right to present oral argument.

The Commission has final decision power over the citation and whether to increase penalties already proposed. The penalty set by the Commissioner is a debt owed to the United States and procedures to recover the debt may include civil action in federal District Court.

The final decision of the Commission is enforceable by the Court of Appeals. An employer who continues to resist the citation further risks additional daily penalties up to $7,000 per day. A final order can take five months before it is issued, so resistance becomes expensive very quickly. The Area Director can assess additional penalties if he feels the contest was solely for delay or avoidance of the penalties.

The final order of the Commission directs the employer to take affirmative action to correct the violation. If the employer does not file a petition for review, the Commission's order and findings of fact become conclusive against the employer. The Court of Appeals has authority to hold the employer in contempt of court for not complying with the order. The court also assesses penalties.

The employer has the right to have the Commission's order reviewed by the Court of Appeals. This review addresses only questions of law or objections raised before the Commission. The Court of Appeals does not review questions of fact, but if evidentiary questions come up, the court may direct the Commission to modify its findings or take new evidence. This does not mean

that the court has the authority to grant temporary relief or a restraining order. It can, however, affirm, modify, or set aside the order of the Commission. These proceedings do not stop the order of the Commission Judge. Failure to abate or obtain a stay from the Court subjects the employer to additional daily penalties that a followup inspection might reveal.

U.S. DEPARTMENT OF LABOR
OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION

Office of Administrative Management
Washington, D.C. 20210

OSHA REGIONAL OFFICES

REGION I*
133 Portland Street
1st Floor
Boston, MA 02114
Telephone: (617) 565-7164

REGION II
201 Varick Street
Room 670
New York, NY 10014
Telephone: (212) 337-2378

REGION III
Gateway Bldg., Suite 2100
3535 Market Street
Philadelphia, PA 19104
Telephone: (215) 596-1201

REGION IV
1375 Peachtree Street, N.E.
Suite 587
Atlanta, GA 30367
Telephone: (404) 347-3573

REGION V
230 South Dearborn Street
32nd Floor, Room 3244
Chicago, IL 60604
Telephone: (312) 353-2220

REGION VI
525 Griffin Street
Room 602
Dallas, TX 75202
Telephone: (214) 767-4731

REGION VII
911 Walnut Street, Room 406
Kansas City, MO 64106
Telephone: (816) 426-5861

REGION VIII
Federal Bldg., Room 1576
1961 Stout Street
Denver, CO 80204
Telephone: (303) 844-3061

REGION IX**
71 Stevenson Street
Suite 415
San Francisco, CA 94105
Telephone: (415) 744-6670

REGION X***
1111 Third Avenue
Suite 715
Seattle, WA 98101-3212
Telephone: (206) 553-5930

*Also under New York Region is the Puerto Rico Area Office and the Virgin Islands.

**Also under the San Francisco Region are Hawaii, Guam, American Samoa, and Trust Territory of the Pacific Islands.

***Also under the Seattle Region is Alaska.

In addition to the Regional Offices listed above, OSHA maintains Area Offices. For your convenience a complete listing of these offices appears on the following pages. We suggest you contact the office nearest you, if you need any assistance, brochures, pamphlets, or have questions on OSHA-related topics.

U.S. Department of Labor

Occupational Safety and Health Administration Area Offices*

ALABAMA

Birmingham, AL 35216
2047 Canyon Road — Todd Mall
Telephone: (205) 731-1534

Mobile, AL 36693
3737 Government Blvd., Suite 100
Telephone: (205) 690-2131

ALASKA

Anchorage, AK 99513-7571
Federal Bldg. — U.S. Courthouse
222 W. 7th St., #29, Rm. 211
Telephone: (907) 271-5152

ARIZONA

Phoenix, AZ 85016
3221 N. 16th St. — Suite 100
Telephone: (602) 640-2007

ARKANSAS

Little Rock, AR 72201
Savers Bldg. — Suite 828
320 W. Capitol Ave.
Telephone: (501) 324-6291

CALIFORNIA

Oakland, CA 94612
7700 Edgewater Dr.
Telephone: (415) 568-8602

Long Beach, CA 90802
400 Oceangate — Suite 530
Telephone: (213) 590-5035

Los Angeles, CA 90020
3550 W. Sixth St. — Room 431
Telephone: (213) 736-3041

COLORADO

Denver, CO 80204
Colonnade Center — Suite 360
1244 Speer Blvd.
Telephone: (303) 844-5285

CONNECTICUT

Hartford, CT 06103
Fed. Office Bldg.
450 Main St., Rm. 508
Telephone: (203) 240-3152

DELAWARE

Wilmington, DE 19801
1 Rodney Square — Suite 402
920 King Street
Telephone: (302) 573-6115

Washington, D.C. 20002
820 1st St., N.E. — Suite 440
Telephone: (202) 523-1452

FLORIDA

Fort Lauderdale, FL 33324
Building H-100
8040 Peters Road
Telephone: (305) 424-0242

Jacksonville, FL 32216
3100 University Blvd. So.
Room 303
Telephone: (904) 791-2895

Tampa, FL 33602
700 Twiggs Street — Room 624
Telephone: (813) 228-2821

GEORGIA

Savannah, GA 31401
1600 Drayton St.
Telephone: (912) 944-4393

Tucker, GA 30084
Building 7 — Suite 110
La Vista Perimeter Office Park
Telephone: (404) 493-6644

HAWAII

Honolulu, HI 96850
300 Ala Moana Blvd. — Suite 5122
P.O. Box 50072
Telephone: (808) 541-2685

IDAHO

Boise, ID 83703
3050 N. Lake Harbor Lane
Suite 134
Telephone: (208) 334-1867

ILLINOIS

Aurora, IL 60542
344 Smoke Tree Business Park
Telephone: (708) 896-8700

Belleville, IL 62220
218 A Main St.
Telephone: (618) 277-5300

Calumet City, IL 60409
1600 167th St., Suite 12
Telephone: (708) 891-3800

Des Plaines, IL 60018
2360 E. Devon Ave. Suite 1910
Telephone: (708) 803-4800

Peoria, IL 61614
100 N.E. Monroe St., Rm 332
Telephone: (309) 671-7033

INDIANA

Indianapolis, IN 46204
46 East Ohio Street — Rm. 422
Telephone: (317) 331-7290

IOWA

Des Moines, IA 50309
210 Walnut Street — Rm. 815
Telephone: (515) 284-4794

KANSAS

Mission, KS 66202
5799 Broadmoor, Suite 338
Telephone: (913) 236-2681

Wichita, KS 67202
216 N. Waco — Suite B
Telephone: (316) 269-6644

KENTUCKY

Frankfort, KY 40601
John C. Watts Federal Bldg. — Rm. 108
330 W. Broadway
Telephone: (502) 227-7024

LOUISIANA

Baton Rouge, LA 70806
2156 Wooddale Blvd.
Hoover Annex — Suite 200
Telephone: (504) 389-0474

MAINE

Augusta, ME 04330
U.S. Federal Bldg. — Room 121
40 Western Avenue
Telephone: (207) 622-8417

MARYLAND

Baltimore, MD 21201
Federal Bldg. — Room 1110
Charles Center, 31 Hopkins Plaza
Telephone: (301) 962-2840

MASSACHUSETTS

Springfield, MA 01103
1145 Main Street — Rm. 108
Telephone: (413) 785-0123

Braintree, MA 02184
639 Granite St. 4th Floor
Telephone: (617) 565-6924

Methuen, MA 01844
13 Branch St., 1st Floor
Telephone: (617) 565-8110

MICHIGAN

Lansing, MI 48917
801 S. Waverly Road — Suite 306
Telephone: (517) 377-1892

MINNESOTA

Minneapolis, MN 55401
110 S. Fourth St., Rm. 425
Telephone: (612) 348-1994

MISSISSIPPI

Jackson, MS 39269
Federal Bldg. — Suite 1445
100 West Capitol Street
Telephone: (601) 965-4606

MISSOURI

Kansas City, MO 64106
911 Walnut St. — Rm. 406
Telephone: (816) 426-5861

St. Louis, MO 63101
911 Washington Ave., Rm. 420
Telephone: (314) 425-4249

MONTANA

Billings, MT 59101
19 North 25th Street
Telephone: (406) 657-6649

NEBRASKA

Omaha, NE 68106
Overland-Wolf Bldg. — Rm. 100
6910 Pacific Street
Telephone: (402) 221-3182

NEVADA

Carson City, NV 89701
1413 N. Carson Blvd., 1st Fl
Telephone: (702) 885-6963

NEW HAMPSHIRE

Concord, NH 03301
279 Pleasant Street
Suite 201
Telephone: (603) 225-1629

NEW JERSEY

Avenel, NJ 07001
Plaza 35 — Suite 205
1030 St. Georges Ave.
Telephone: (201) 750-3270

Marlton, NJ 08053
Marlton Executive Park
Blgd. 2, Suite 120
701 Route 73 S.
Telephone: (609) 757-5181

Parsippany, NJ 07054
299 Cherry Hill Road
Telephone: (201) 263-1003

Hasbrouck Heights, NJ 07604
Teterboro Airport Professional Bldg.
500 Route 17 — Rm. 206
Telephone: (201) 288-1700

NEW MEXICO

Albuquerque, NM 87102
320 Central Avenue S.N.
Suite 13
Telephone: (505) 776-3411

NEW YORK

Albany, NY 12207
Leo W. O'Brien Federal Building
Clinton Ave. & N. Pearl St., Rm. 132
Telephone: (518) 472-6085

Bayside, NY 11361
42-40 Bell Blvd.
Telephone: (718) 279-9060

Bowmansville, NY 14026
5360 Genessee St.
Telephone: (716) 684-3891

New York, NY 10007
90 Church Street — Rm. 1405
Telephone: (212) 264-9840

Syracuse, NY 13260
100 So. Clinton Street — Rm. 1267
Telephone: (315) 423-5188

Terrytown, NY 10591
660 White Plain Rd. 4th Fl
Telephone: (914) 683-9530

Westbury, NY 11590
990 Westbury Road
Telephone: (516) 334-3344

NORTH CAROLINA

Raleigh, NC 27601
Century Station — Rm. 104
300 Fayetteville Mall
Telephone: (919) 856-4770

NORTH DAKOTA

Bismarck, ND 58501
Federal Bldg. — Rm. 348
P.O. Box 2439
Telephone: (701) 250-4521

OHIO

Cincinnati, OH 45246
36 Triangle Park Drive
Telephone: (513) 771-5814

Cleveland, OH 44199
Federal Office Bldg. — Rm. 899
1240 East Ninth Street
Telephone: (216) 522-3818

Columbus, OH 43215
Federal Office Bldg. — Rm. 620
200 N. High Street
Telephone: (614) 469-5582

Toledo, OH 43604
Federal Office Bldg. — Rm. 734
234 North Summit Street
Telephone: (419) 259-7542

OKLAHOMA

Oklahoma City, OK 73102
420 W. Main Place — Suite 725
Telephone: (405) 231-5351

OREGON

Portland, OR 97204
1220 S.W. Third Street — Rm. 640
Telephone: (503) 326-2251

PENNSYLVANIA

Allentown, PA 18102
850 N. 5th Street
Telephone: (215) 776-0592

Erie, PA 16506
3939 N. Ridge Road
Suite B-12
Telephone: (814) 833-5758

Harrisburg, PA 17109
Progress Plaza
49 N. Progress St.
Telephone: (717) 782-3902

Philadelphia, PA 19106
U.S. Customs House — Rm. 242
2nd & Chestnut St.
Telephone: (215) 597-4955

Pittsburgh, PA 15222
Federal Building — Rm. 1428
1000 Liberty Ave.
Telephone: (412) 644-2903

Wilkes-Barre, PA 18701
Penn Place — Rm. 2005
20 North Pennsylvania Avenue
Telephone: (717) 826-6538

PUERTO RICO

Hato Rey, PR 00918
U.S. Courthouse & FOB
Carlos Chardon Ave. — Rm. 555
Telephone: (809) 766-5457

RHODE ISLAND

Providence, RI 02903
380 Westminster Mall — Rm. 243
Telephone: (401) 528-4669

SOUTH CAROLINA

Columbia, SC 29201
1835 Assembly St., Rm. 1468
Telephone: (803) 765-5904

TENNESSEE

Nashville, TN 37215
2002 Richard Jones Road
Suite C-205
Telephone: (615) 736-5313

TEXAS

Austin, TX 78701
611 E. 6th St. — Rm. 303
Telephone: (512) 482-5783

Corpus Christi, TX 78401
Government Plaza — Rm. 300
400 Main St.
Telephone: (512) 888-3257

Dallas, TX 75228
8344 East R. L. Thornton Freeway
Suite 420
Telephone: (214) 320-2400

Fort Worth, TX 76180-7604
North Starr II, Suite 430
8713 Airport Freeway
Telephone: (817) 885-7025

Houston, TX 77004
2320 La Branch Street — Rm. 1103
Telephone: (713) 750-1727

Lubbock, TX 79401
Federal Bldg. — Rm. 421
1205 Texas Avenue
Telephone: (806) 743-7681

UTAH

Salt Lake City, UT 84115
1781 So. 300 West
P.O. Box 15200
Telephone: (801) 524-5080

VIRGINIA

Norfolk, VA 23510
Federal Office Bldg., Rm. 835
200 Granby Mall
Mail Drawer 486
Telephone: (804) 441-3820

WASHINGTON

Bellevue, WA 98004
121 107th Street, N.E. — Rm. 110
Telephone: (206) 553-7520

WEST VIRGINIA

Charleston, WV 25301
550 Eagan St. — Rm. 206
Telephone: (304) 347-5937

WISCONSIN

Appleton, WI 54915
2618 North Ballard Road
Telephone: (414) 734-4521

Eau Claire, WI 54701
Federal Bldg. U.S. Courthouse
500 Barstow St. — Rm. B-9
Telephone: (715) 832-9019

Madison, WI 53203
2934 Fish Hatchery Rd. — Suite 220
Telephone: (608) 264-5388

Milwaukee, WI 53203
310 West Wisconsin Ave. — Rm. 1180
Telephone: (414) 297-3315

* Please note that some of these offices are temporary, and the numbers and addresses will often change. If you cannot find the correct number, call OSHA headquarters at (202) 523-9308.

This page reserved for future reference material.

APPENDIX II: STANDARDS ADOPTED BY OSHA

The Administrative Procedures Act for the establishment of permanent standards under OSHA to be used as the laws by the OSHA compliance officers involves publishing the proposed text of standards in the Federal Register, providing time for filing comments, setting a time and place for a public hearing, and issuing a rule including the standard.

The Secretary of Labor may, within two years after the effective date of the Act, put into effect any national consensus standard and those established Federal Safety Standards in effect on April 20, 1971 as interim standards, unless he determines that the promulgation of such standards would not result in improved safety or health.

The Occupational Safety and Health Standards published in the most recent issue of the Federal Register are based on consensus standards and established federal standards and laws under OSHA.

PUBLICATION NUMBER	CODE	REFERENCE
Bulletin 210 (4-62)	Test Code for Testing Air Moving Devices	Air Moving and Conditioning Association 30 West University Drive Arlington Heights, Illinois 60004
	Industrial Ventilation Threshold Limit Values of Airborne Contaminants of 1970	American Conference of Governmental Hygienists 1014 Broadway Cincinnati, Ohio 45202
SD Catalogue No. C 13.20/2:20-70	American Lumber Standard	American Lumber Standards Committee P.O. Box 1554 Rockville, Maryland 20880
A 10.1-1944	Building Construction, Safety Code for †	American National Standards Institute 1430 Broadway New York, New York 10018
A 10.3-1970	Explosive-Actuated Fastening Tools	
A 10.4-1963	Workmen's Hoists	
A 10.5-1969	Material Hoists	
A 10.8-1969	Scaffolding	
A 10.9-1970	Concrete Construction and Masonry Work	
A 11.1-1965	Industrial Lighting	
A 12.1-1967	Floor and Wall Openings, Railings and Toe Boards	
A 13.1-1956	Identification of Piping Systems	
A 14.1-1968	Portable Wood Ladders	
A 14.2-1956	Portable Metal Ladders	
A 14.3-1956	Fixed Ladders	
A 17.1-1965	Elevators, Dumbwaiters, and Moving Walks	
A 17.2-1970	Elevators	
A 40.8-1955	National Plumbing Code	
A 58.1-1955	Minimum Design Loads in Buildings and Other Structures	
A 64.1-1968	Fixed Industrial Stairs	
A 90.1-1969	Manlifts	
A 92.1-1971	Mobile Ladder Stands and Scaffolds (Towers), Manually Propelled	
A 92.2-1969	Vehicle Mounted Elevating and Rotating Platform	
A 120.1-1970	Powered Platforms for Exterior Building Maintenance	
B 7.1-1970	Use, Care and Protection of Abrasive Wheels	
B 9.1-1964	Mechanical Refrigeration	
B 11.1-1971	Construction, Care and Use of Mechanical Power Presses	
B 15.1-1953	Mechanical Power	
B 20.1-1957	Conveyors, Cableways and Related Equipment	
B 24.1-1963	Forging and Hot Metal Stamping	

†Out of print, or available from libraries only.

PUBLICATION NUMBER	CODE	REFERENCE
B 28.1-1967	Mills and Calendars in the Rubber and Plastic Industries	
B 30.1-1943	Jacks	
B 30.2-1943	Cranes, Derricks and Hoists	
B 30.2.0-1967	Overheads and Gantry Cranes	
B 30.5-1968	Crawler, Locomotive and Truck Cranes	
B 30.6-1969	Derricks	
B 31.1-1955	Power Piping with Addenda	†
B 31.2-1968	Fuel Gas Piping	
B 31.3-1966	Petroleum Refinery Piping	
B 31.5-1966	Refrigeration Piping with Addenda	
B 56.1-1969	Powered Industrial Trucks	
B 57.1-1965	Compressed Gas Cylinders Value Outlet and Inlet Connections	
B 71.1-1968	Power Lawn Mowers	
B 114.1-1971	Emblem for Identifying Slow Moving Vehicles	
B 125.1-1970	Welded and Seamless Steel Pipe	
C 1-1968	National Electrical Code	
C 2.2-1960	Installation and Maintenance of Electrical Supply and Communication Lines	
C 95.1-1966	Electromagnetic Radiation with Respect to Personnel	
C 95.2-1966	Radio Frequency Radiation Hazard Warning Signal	
D 6.1-1969	Manual on Uniform Traffic Control Devices for Streets and Highways	
D 8.1-1967	Railroad Highway Grade Crossing Protection	
G 41.5-1970	Structural Steel	
H 23.1-1970	Seamless Copper Water Tube	
H 38.7-1969	Aluminum Alloy Seamless Pipe and Seamless Extruded Tube	
J 6.1-1950	Rubber Insulating Line Hose	
J 6.2-1950	Rubber Insulator Hoods	†
J 6.4-1970	Rubber Insulating Blankets	†
J 6.5-1962	Rubber Insulating Sleeves	†
J 6.6-1967	Rubber Insulating Gloves	†
J 6.7-1935	Rubber Matting for the Use Around Electrical Apparatus	†
K 13.3-1967	Identification of Gas-Mask Canisters	
K 61.1-1966	Storage and Handling of Anhydrous Ammonia	
L 1.1-1956	Textile Safety Code	
N 2.3-1967	Immediate Evacuation Signal for Use in Industrial Installations Where Radiation Exposure May Occur	

†Out of print, or available from libraries only.

PUBLICATION NUMBER	CODE	REFERENCE
O 1.1-1954	Woodworking Machinery	
O 2.1-1969	Sawmills	
O 3.1-1971	Pulpwood Logging	
P 1.1-1969	Pulp, Paper and Paperboard Mills	
Z 4.1-1968	Sanitation in Places of Employment	
Z 4.2-1942	Drinking Fountains	
Z 4.3-1970	Non-Water Carriage Disposal Systems	
Z 4.4-1968	Sanitation in Temporary Labor Camps	
Z 8.1-1961	Laundry Machinery and Operations	
Z 9.1-1951	Ventilation and Operations	
Z 9.2-1960	Design and Operation of Local Exhaust Systems	
Z 9.3-1964	Design, Construction, and Ventilation of Spray Finishing Operations	
Z 9.4-1968	Ventilation and Safe Practices of Abrasives Blasting Operations	
Z 11.189-1966	Autoignition Temperatures of Liquid Petroleum Products	
Z 12.12-1968	Sulphur Fires and Explosives	
Z 12.20-1962	Woodworking and Wood Floor Manufacturing Plants	
Z 21.30-1964	Gas Appliance and Gas Piping Installations	
Z 24.22-1957	Measurement of the Real-Ear Attenuation of Ear Protectors Threshold	
Z 33.1-1961	Installation of Blower and Exhaust Systems for Dust, Stock, and Vapor Removal or Conveying	
Z 35.1-1968	Accident Prevention Signs	
Z 35.2-1968	Accident Prevention Tags	
Z 37.2-1966	Hydrogen Sulfide	
Z 37.3-1968	Carbon Disulfide	
Z 37.4-1969	Benzene	
Z 37.5-1970	Cadmium Fume and Cadmium Dusts	
Z 37.7-1943	Chromic Acid and Chromates	
Z 37.8-1943	Mercury	
Z 37.11-1967	Lead and its Inorganic Compounds	
Z 37.12-1967	Toluene	
Z 37.15-1969	Styrene	
Z 37.16-1967	Formaldehyde	
Z 37.17-1967	Carbon Tetrachloride	
Z 37.18-1969	Methyl Chloride	
Z 37.19-1967	Trichloroethylene	
Z 37.21-1967	Ethylene Dichloride	
Z 37.22-1967	Tetrachloroethylene	

PUBLICATION NUMBER	CODE	REFERENCE
Z 37.23-1969	Methylene Chloride	
Z 37.28-1966	Hydrogen Fluoride and Inorganic Fluoride Dust	
Z 37.29-1970	Beryllium and Beryllium Compounds	
Z 37.30-1969	Organo (Alkyl) Mercury	
Z 37.31-1970	Ethylene Dibromide	
Z 41.1-1967	Men's Safety-Tow Footwear	
Z 43.1-1966	Ventilation Control of Grinding, Polishing, and Buffing Operations	
Z 48.1-1954	Marking Portable Compressed Gas Containers to Identify the Material Contained	
Z 49.1-1967	Welding and Cutting	
Z 50.1-1947	Bakery Equipment	
Z 53.1-1967	Marking Physical Hazards and the Identification of Certain Equipment	
Z 54.1-1963	Non-Medical X-Ray and Sealed Gamma-Ray Sources	
Z 87.1-1968	Occupational and Educational Eye and Face Protection	
Z 88.2-1969	Practices for Respiratory Protection	
Z 89.1-1969	Industrial Head Protection	
Z 89.2	Industrial Protective Helmets for Electrical Workers	
API Std. 12A	Specification for Oil Storage Tanks With Riveted Shells	American Petroleum Institute
API Std. 12B	Specification for Bolted Production Tanks	1801 K Street N.W.
Supplement No. 1	*Ibid.*	Washington, D.C. 20006
API Std. 12D	Specification for Large Welded Production Tanks	
Supplement No. 1	*Ibid.*	
API Std. 12F	Specification for Small Welded Production Tanks	
API Std. 620	Recommended Rules for Design and Construction Large, Welded, Low-Pressure Storage Tanks	
API Std. 650	Welded Steel Tanks for Oil Storage	
API Std. 1104	Standard for Welding Pipelines and Related Facilities	
API Std. 2000	Venting Atmospheric and Low-Pressure Storage Tanks	
API PSD 2201	Welding or Hot Topping on Equipment Containing Flammables	
API ASME 1951 Ed.	Code for Unfired Pressure Vessels for Petroleum Liquids and Gases †	
ASAE R 276	Emblem for Identifying Slow Moving Vehicles	American Society of Agricultural Engineer
ASAE S276.2	Slow Moving Vehicle Identification Emblem	1950 Niles Avenue
		St. Joseph, Michigan 49085

†Out of print, or available from libraries only.

PUBLICATION NUMBER	CODE		REFERENCE
Section I-1949	Power Boilers	†	American Society of Mechanical Engineers
Section I-1968	Power Boilers	†	345 East 47th Street
Section VIII-1950	Pressure Vessels-Division 1	†	New York, New York
Section VIII-1952	Pressure Vessels-Division 1	†	
Section VIII-1956	Pressure Vessels-Division 1	†	
Section VIII-1959	Pressure Vessels-Division 1	†	
Section VIII-1962	Pressure Vessels-Division 1	†	
Section VIII-1965	Pressure Vessels-Division 1	†	
Section VIII-1968	Unfired Pressure Vessels-Division 1	†	
ASTM A47-68	Specifications for Malleable Iron Castings	†	American Society for Testing and Material
ASTM A53-69	Specifications for Welded and Seamless Pipe	†	1916 Race Street
ASTM A126-66	Specifications for Gray Iron Castings for Valves, Flanges and Pipe Fittings		Philadelphia, Pennsylvania 19103
ASTM A395-68	Specifications for Ductile Iron for Pressure Containing Castings for Use at Elevated Temperatures	†	
ASTM B88-69	Specification for Seamless Copper Water Tube		
ASTM B241-69	Specification for Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube	†	
ASTM D56-69	Standard Method of Test for Flash Point by the Tag Closed Tester	†	
ASTM D86-67	Test for Distillation of Petroleum Products		
ASTM D93-66	Test for Flash Point by Pensky-Martens Closed Tester		
ASTM D323-68	Standard Method of Test for Vapor Pressure of Petroleum Products		
ASTM D1962-68	Test for Flammability of Plastic Sheeting and Cellular Plastics		
A6.1-1966	Recommended Safe Practices for Gas-Shielded Arc Welding		American Welding Society
D1.0-1966	Code for Welding in Building Construction	†	2501 N.W. 7th Street Miami, Florida 33125
C-6-1968	Standard for Visual Inspection of Compressed Gas Cylinders		Compressed Gas Association
C-8-1962	Standard for Requalification of ICC-3HT Cylinders		500 Fifth Avenue New York, New York 10036
G-1-1966	Acetylene		
G-1.3-1959	Acetylene Transmission for Chemical Synthesis		
G1.4-1966	Standard for Acetylene Cylinder Charging Plants		
G-4-1962	Oxygen		
G-5.1-1961	Standard for Gaseous Hydrogen Systems at Consumer Sites		

†Out of print, or available from libraries only.

PUBLICATION NUMBER	CODE		REFERENCE
G-5.2-1966	Standard for Liquified Hydrogen at Consumer Sites		
G-7.1-1966	Commodity Specifications for Air		
G-8.1-1964	Standard for the Installation of Nitrous Oxide Systems at Consumer Sites		
P-1-1965	Safe Handling of Compressed Gases		
P-3	Standards for Solid Ammonium Nitrate		
S-1.1-1963	Safety Relief Devices Standards—Cylinders for Compressed Gases		
S-1.2-1963	Safety Relief Device Standards—Cargo and Portable Tanks for Compressed Gases		
S-1.3-1966	Safety Relief Device Standards Compressed Gas Storage Containers		
CGA-1958	Regulator Connection Standards	†	
CGA-1957	Standard Hose Connection Specifications	†	
CGA-1958	Specifications for Rubber Welding Hose	†	
	Specification No. 61	†	Crane Manufacturers Association of America c/o The Material Handling Inst., Inc. 1326 Freeport Road Pittsburgh, Pennsylvania 15238
IME Pamphlet No. 17	Safety in the Handling and Use of Explosives	†	Institute of Makers of Explosives 420 Lexington Avenue New York, New York 10017
IME 20	Radio Frequency Energy		
TSC 12-65	Self-Contained, Electrically Operated Recirculating, Chemically Controlled Toilet		International Association of Plumbing and Mechanical Officials 5032 Alhambra Avenue Los Angeles, California
NFPA 10-1970	Standard for the Installation of Portable Fire Extinguishers		National Fire Protection Association 60 Batterymarch Street Boston, Massachusetts 02110
NFPA 10A-1970	Maintenance and Use of Portable Fire Extinguishers		
NFPA 11-1970	Standard for Foam Extinguishing Systems		
NFPA 12-1968	Standard for Carbon Dioxide Extinguishing Systems		
NFPA 13-1969	Standard for the Installation of Sprinkler Systems		
NFPA 14-1970	Standard for the Installation of Standpipe and Hose Systems		
NFPA 15-1969	Standard for Water Spray Fixed Systems for Fire Protection		
NFPA 17-1969	Standard for Dry Chemical Extinguishing System		

†Out of print, or available from libraries only.

PUBLICATION NUMBER	CODE	REFERENCE
NFPA 20-1970	Standard for Installation of Centrifugal Fire Pumps	
NFPA 22-1970	Standard for Water Tanks for Private Fire Protection	
NFPA 24-1970	Standard for Outside Protection	
NFPA 30-1969	Flammable and Combustible Liquids Code	
NFPA 31-1968	Standard for the Installation of Oil Burning Equipment	
NFPA 33-1969	Standard for Spray Finishing Using Flammable and Combustible Materials	
NFPA 34-1966	Standard for Dip Tanks Containing Flammable or Combustible Liquids	
NFPA 37-1970	Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines	
NFPA 50B-1968	Standard for Liquified Hydrogen Systems at Consumer Sites	
NFPA 51-1969	Standard for Installation & Operation of Oxygen-Fuel Gas System for Welding and Cutting	
NFPA 51B-1962	Standard for Fire Protection in Use of Cutting and Welding Processes	
NFPA 54-1969	Standard for the Installation of Gas Appliances and Gas Piping	
NFPA 54A-1969	Standard for the Installation of Gas Piping and Gas Equipment on Industrial Premises and Certain Other Premises	
NFPA 58-1969	Standard for the Storage and Handling of Liquified Petroleum Gases	
NFPA 62-1967	Standard for Dust Hazards of Sugar and Cocoa	
NFPA 68-1954	Guide for Explosive Venting	
NFPA 70-1968	National Electrical Code	
NFPA 72A-1967	Standard for the Installation, Maintenance, and Use of Local Protective Signaling Systems for Watchman, Fire Alarm, and Supervisory Services	
NFPA 78-1968	Lightning Protection Code	
NFPA 80-1970	Standard for Fire Doors and Windows	
NFPA 86A-1969	Standard for Ovens and Furnaces, Design, Location and Equipment	
NFPA 91-1970	Standard for the Installation of Blower and Exhaust Systems for Dust, Stock, and Vapor Removal or Conveying	

†Out of print, or available from libraries only.

PUBLICATION NUMBER	CODE	REFERENCE
NFPA 96-1970	Standard for the Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment	
NFPA 101-1970	Code for Life Safety from Fire in Buildings and Structures	
NFPA 194-1968	Standard for Screw Threads Gaskets for Fire Hose Couplings	
NFPA 198-1969	Standard for Care of Fire Hose	
NFPA 203M-1970	Manual on Roof Coverings	
NFPA 220-1961	Standard Types of Building Construction	
NFPA 231-1970	Standard for Indoor General Storage	
NFPA 251-1969	Standard Methods of Fire Tests of Building Construction and Materials	
NFPA 302-1968	Standard for the Fire Protection of Motorcraft	
NFPA 385-1966	Standard for Tank Vehicles for Flammable and Combustible Liquids	
NFPA 495-1970	Code for Manufacturing, Transportation Storage and Use of Explosives and Blasting Agents	
NFPA 496-1967	Standard for Purged Enclosures for Electrical Equipment in Hazardous Locations	
NFPA 505-1969	Standard for Type Designations, Areas of Use, Maintenance, and Operation of Powered Industrial Trucks	
NFPA 566	Standard for Installation of Bulk Oxygen Systems at Consumer Sites †	
NFPA 656-1959	Code for the Prevention of Dust Ignition in Spice Grinding Plants	
	Defination and Test Procedures for Ammonium Nitrate Fertilizer	National Plant Food Institutes 1700 K Street, N.W. Washington, D.C. 20006
PCSA 1-1968	Mobile Power Crane and Excavator Standard	Power Crane and Shovel Association
PCSA 2-1968	Mobile Hydraulic Crane Standard	Suite 1700 Marine Plaza
PCSA 3-1969	Mobile Hydraulic Excavator Standard	111 E. Wisconsin Avenue Milwaukee, Wisconsin 53202
RMA-1958	Specification for Rubber Welding Hose, RMA Handbooks	Rubber Manufacturers Association 444 Madison Avenue New York, New York

†Out of print, or available from libraries only.

PUBLICATION NUMBER	CODE		REFERENCE
SAE J. 166-1971	Minimum Performance Criteria for Brake Systems for Off-Highway Trucks and Wagons	†	Society of Automotive Engineers 2 Pennsylvania Plaza New York, New York 10001
SAE J. 236-1971	Minimum Performance Criteria for Brake Systems for Rubber-Tired, Self-Propelled Graders	†	
SAE J. 237-1971	Minimum Performance Criteria for Off-Highway, Rubber-Tired, Front End Loaders and Dozers	†	
SAE J. 319b-1971	Minimum Performance Criteria for Brake Systems for Off-Highway, Rubber-Tired, Self-Propelled Scrapers	†	
SAE J. 321a-1970	Fenders for Pnuematic-Tired Earthmoving Haulage Equipment	†	
SAE J. 333a-1970	Operator Protection for Wheel Type Agricultural and Industrial Tractors	†	
SAE J. 386-1969	Seat Belts for Construction Equipment	†	
SAE J. 959-1966	Lifting Crane, Wire Robe Strength Factors	†	
SAE J. 765-4-61-2-69	Crane Load-Stability Test Code		
	SAE Handbook-1970		
SAE 326	Nomenclature–Utility Backhoe		
SAE 727a	Nomenclature–Tractor (Track Type)		
SAE 728	Nomenclature–Scrapers		
SAE 729	Nomenclature–Bulldozer		
SAE 730a	Nomenclature–Cable Control Units		
SAE 731c	Nomenclature–Loader (Front End)		
SAE 732c	Specifications Defination–Front End Loader		
SAE 733a	Nomenclature–Rippers, Rooters, Scarifiers		
SAE 734a	Nomenclature–Wagons		
SAE 869	Nomenclature–Two and Four Wheel Tractors		
SAE 870	Nomenclature–Motor Grader		
SAE 894	Terminology–Construction and Industrial Machinery		
SAE 958	Nomenclature and Dimensions for Crane Shovels		
SAE 990	Nomenclature–Industrial Mowers		
U.L. Standard 58	Standard for Steel Underground Tanks for Flammable and Combustible Liquids		Underwriters' Laboratories, Inc. (Fire, Casualty and Crime Protection Engineering) 207 E. Ohio Street Chicago, Illinois
U.L. Standard 80	Standard for Steel Inside Tanks for Oil Burner Fuel		
U.L. Standard 142	Standard for Steel Above Ground Tanks for Flammable and Combustible Liquids		
CFR Title 29 Part 900 to end	Ship Repairing		Office of the Federal Register Eight Street and Pennsylvania Avenue N.W. Washington, D.C. 20408
CRF Title 29 Part 900 to end	Shipbuilding	†	
CFR Title 29 Part 900 to end	Shipbreaking	†	

†Out of print, or available from libraries only.

PUBLICATION NUMBER	CODE		REFERENCE
CFR Title 29 Part 900 to end	Longshoring	†	
CFR Title 41 Chapter 19 to 100	Occupational Noise Exposure		
CFR Title 41 Chapter 19 to 100	Public Contracts and Property Management Radiation	†	
CFR Title 41 Chapter 41	Public Contracts and Property Management Oxygen	†	
CFR Title 41 Chapter 19 to 100	Public Contracts and Property Management Acetylene	†	
CFR Title 41 Chapter 19 to 100	Personal Protective Equipment	†	
CFR Title 41 Chapter 19 to 100	Medical Services and First Aid	†	
CFR Title 41 Chapter 19 to 100	Inspection of Compressed Gas Cylinders	†	
CFR Title 41 Chapter 19 to 100	Public Contracts and Property Management Material Handling and Storage	†	
CFR Title 41 Chapter 19 to 100	Machine Guarding	†	
CFR Title 41	Tools and Equipment	†	
Chapter 19 to 100	Use of Compressed Air		
CFR Title 14 Part 60 to 199	Part 103, Transportation of Dangerous Articles and Magnetized Materials		
CFR Title 30	Aeronautics and Space Part 11, Self-Contained Breathing Apparatus		
CFR Title 41 Chapter 19 to 100	Mineral Resources Subpart D, Gasses, Vapors, Fumes, Dusts, and Mists		
CFR Title 46 Part 146 to 149	Public Contracts and Property Management Subpart 146.22, Detailed Regulations Governing Inflammable Solids and Oxidizing Materials		
CFR Title 49 Parts 1 to 199	Shipping; Transportation Parts 171-179, Chapter I, Hazardous Materials Regulation Board, and Department of Transportation		
USDA Handbook No. 41	Checklist of Native and Naturalized Trees of the United States (including Alaska)		U. S. Department of Agriculture Rural Development and Conservation Forest Service
USDA Technical Bulleting No. 479	Strength & Related Properties of Wood Grown in the U.S.	†	14th Street and Independence St., N.W.
USDA Handbook No. 72	Wood Handbook	†	Washington, D.C. 20250
U.S. Public Health Service Publication No. 546-1965	Vending of Foods and Beverages, A Sanitation Ordinance and Code	†	Department of Health, Education and Welfare Public Health Service
U.S. Public Health Service Publication No. 934-1965	Food Service Sanitation Ordinance and Code Part V. Food Service Sanitation Manual		Food and Drug Administration 5600 Fishers Lane Rockville, Maryland 20852

†Out of print, or available from libraries only.

PUBLICATION NUMBER	CODE	REFERENCE
Schedule 30	Hydraulic Power Tools	Director, U. S. Bureau of Mines Department of Interior Washington, D.C. 20240
BB-A-1034a	Federal Specification Air, Compressed for Breathing Purposes	General Services Administration Federal Supply Service 1941 Jefferson Davis Highway Arlington, Virginia
BB-A-1034a **Amendment 1	Federal Specification Air, Compressed for Breathing Purposes	
GG-B-00675b	Interim Federal Specification Breathing Apparatus, Self-Contained	
QQ-P-416	Federal Specifications Plating, Cadmium	
USP 18-1970	Oxygen Pharmacopeia of the U. S.	U. S. Pharmacopoeial Convention 4630 Montgomery Avenue Bethesda, Maryland 20014

accessory. Such determinations will depend upon the particular facts of each case, and will necessarily be made on a case-by-case basis. Section 17(f) makes it a misdemeanor for any person to give advance notice of an inspection. Section 17(g) is a misdemeanor provision relating to false statements knowingly made. Section 17(h) pertains to any person who assaults an officer or employee of the Department of Labor.

75. Who has the legal liability for reporting accidents — the person who signs the form, the local manager, or a company executive officer?

The employer.

76. Is it a criminal offense not to list a reportable injury or illness within 48 hours?

It may be, under Section 17(g).

77. If employees willfully do not use proper equipment or follow prescribed safety rules, will the employer be relieved of possible penalties?

The Act contains no provision for relieving employers of penalties in such cases. However, the penalty may be reduced if it appears the employer has made a good-faith effort to comply.

78. Can a complaint regarding an alleged violation be filed by a nonemployee, such as an insurance company representative?

The Act requires response to complaints in writing filed by employees or their representatives. Normally, an insurance company representative would not be in these categories.

79. Will OSHA consider a blanket request for variance?

Yes, if the request is made by employers or classes of employers.

80. How can I keep up to date on changes in the standards?

All new standards, modifications of standards, and revocations of standards are published in the Federal Register. Subscriptions are available from the Government Printing Office.

81. Where can I obtain authoritative interpretations of the standards?

Inquiries should be directed to the OSHA Regional Administrator, Area Director or District Director in the state or states concerned. If necessary, inquiries can be sent to the OSHA Office of Safety and Health Standards.

82. Can an employer dismiss an employee who does not comply with OSHA standards after he or she is ordered to do so?

An employer may generally consider occupational safety and health standards to be mandatory workplace rules that must be complied with by employees in the workplace. Employees who refuse to comply may be subjected to whatever disciplinary action the employer deems appropriate.

59. When should an occupational illness be recorded?

As of the date of diagnosis or, if the diagnosis follows a period in which the employee has been unable to work for unknown reasons, the date of the first day of absence under that illness.

60. How long must the summary be posted at each establishment?

The summary will be completed and posted no later than February 1 and will remain in place for 30 consecutive calendar days.

61. If an employee transfers to another job within his or her occupational classification because of an injury, must this be recorded?

If the transfer is caused by an injury or illness, it is reportable.

62. Why can't OSHA obtain the needed information from existing workers compensation records?

Because workers compensation records are not uniform from state to state.

63. If a doctor indicates an employee is able to work but the employee feels unable to work and misses a day or more, must these be recorded as lost workdays?

If the employee cannot perform all the duties of the original job, then the absent days are counted as lost workdays. Where there is a difference of opinion, the judgment rests with the employer.

64. Is it necessary to give a doctor's diagnosis as received on the claim form, or can an employer use a general diagnosis by the company nurse?

Only a brief diagnosis is necessary. An accurate nurse's diagnosis will do.

Miscellaneous

65. What is the new basis for the injury rate?

Two hundred thousand man-hours, based on 100 full-time employees working 40 hours a week for 50 weeks. Hours and weeks worked may vary from industry to industry, but the same base will be used for all.

66. When will accident data and rates be published, and how often?

OSHA plans an annual survey and annual publication.

67. What will OSHA do to eliminate unsafe employee habits and acts?

OSHA is working with the National Institute for Occupational Safety and Health (NIOSH), which has primary responsibility in studying methods to motivate both the employer and the employee.

68. How are the Target Industries selected?

On the basis of having high injury frequency rates, all of which are more than double the national average.

69. What kind of research is OSHA conducting?

Primarily on administrative matters such as program effectiveness and organizational structure, as well as on improving statistical programs. Technical research on criteria for new and improved standards, identification of toxic substances and similar factors are being conducted by the National Institute for Occupational Safety and Health within the Department of Health, Education, and Welfare.

70. Does the equipment dealer have an obligation under the Occupational Safety and Health Act to make certain his or her products meet safety regulations?

No, not in the capacity as a seller or lessor of goods. The Act imposes safety obligations only on employers and employees.

71. How does the Act affect workers compensation laws?

It does not. However, it provides for a fifteen-member National Commission on State Workers Compensation Laws to determine if such laws provide an adequate, prompt, and equitable system of compensation for job-related deaths or injuries.

72. What is the function of the Occupational Safety and Health Review Commission?

The Review Commission is a wholly independent, *quasi* judicial body that reviews contested cases of alleged violations, issues corrective orders, and assesses civil penalties.

73. The Act provides criminal penalties for false statements. Do these apply to both employers and employees?

Yes, but as a practical matter the employer usually makes the statements, representations, etc., and therefore would normally be the one to be penalized.

74. To whom would a prison term apply, if assessed as a penalty?

Anyone convicted of violating the provisions of Sections 17(e), (f), (g) or (h) shall be punished by a fine, or by imprisonment, or by both. Such criminal sanctions are not ''assessed'' as such. Rather, they may be imposed only after prosecution and conviction of the person or persons charged in U.S. District Courts in accordance with the Federal Rules of Criminal Procedure. Under Section 17(e), any employer may be prosecuted for a willful violation of any standard, rule, or order promulgated under Section 6, or any regulation prescribed pursuant to the Act that caused death to any employee. Section 17(e) is directed toward ''any employer,'' which usually will be an individual, a partnership, or a corporation. In the latter case, the conduct of business in the corporate form will not necessarily immunize individual officers of the corporation from criminal responsibility. A corporate officer may be criminally liable if he or she participates in the unlawful act either directly, as a principal, or indirectly, as an aider, abettor, or

42. When should an employer record a disputed job illness?

The employer or designee should decide at the time an alleged occupational illness is learned of whether it is recordable and, based on that decision, record it or not. If it later develops that the illness was not work-connected, it can be lined out of the record. However, failure to record may subject an employer to penalties.

43. If an employer in good faith decides an injury is not reportable and later finds it should have been reported, can the log be amended?

Yes, when he or she determines the injury is recordable, even though this may occur after the time limit for recording.

44. Is recordkeeping on the basis of the calendar or federal fiscal year (July 1 — June 30)?

It is on a calendar year basis — January 1 to December 31.

45. How is lost time determined for a casual, day-to-day worker who is injured and does not return to his or her original employer?

If the injury is compensable, with medical costs, the employer would know of it and make an appropriate entry. But in cases where, after a few days, the employer never hears from the employee, the employer cannot be expected to count lost workdays, so these should be considered a termination of employment.

46. If an employee working in an establishment on a contract basis is injured, is the injury recordable on the establishment summary, or on that of the contractor?

The contractor who is the immediate employer would record this.

47. Is there a time limit for an employee to report an injury?

No. The duty to report is on the employer, not the employee. The employer must record the injury within six working days of receipt of information.

48. Must records be kept by "department" at a multi-building establishment where various departments have significantly different potential hazards?

No. If the departments comprise one "establishment," only one set of consolidated records need be maintained.

49. Can the summary at the end of a period be on a total company basis or must it be broken down into the individual reporting locations?

It should be provided at the local establishment level rather than at a central location, since the purpose of the summary is to provide employees and management at the local level with information on the experience at the local establishment level.

50. If an establishment has more than one operation facility, each with its own management but where all facilities utilize a single medical department and one personnel office, must separate logs be kept at each facility or can one log and summary be kept for all facilities at one location?

Individual logs must be kept for each facility.

51. If each of several manufacturing facilities has separate trucking operations, must separate logs be maintained by each fleet?

If each fleet is a separate establishment, it must keep a separate record.

52. If there is more than one follow-up visit to the nurse for cuts or burns, is such an injury to be recorded?

If the follow-up visit is only for observation or to change a bandage, the injury would not be recorded.

53. If an injured employee returns to normal duties after receiving first aid, is this recordable?

If the employee receives only first aid, the case is not recordable. Similarly, if no time is lost except on the day on which the injury occurred, it is not recordable as a lost workday case.

54. If an employee receives a minor injury requiring only first aid but cannot return to his or her normal job duties for one or two days, is the injury recordable?

Yes.

55. When an injured employee returns to work with long-term medical restrictions, when do lost workdays cease to accumulate?

If the restrictions prevent the performance of any duties normally assigned to his or her job, each day the employee cannot perform such duties must be counted. At some point, the job may be redefined as a new one, the counting of lost workdays will cease, and the employee will be treated as terminated in the former job.

56. If total disability ends the counting of lost workdays, does retirement also do so?

Yes. Separation by total disability and by retirement have the same effect. Both are treated as terminations.

57. If normal work schedules include overtime days, are they counted as lost workdays for an injured employee?

Yes. If the employee would have worked the overtime days if the injury never occurred.

58. If an employer reports or records accidents and illnesses to another federal agency, must he or she participate in OSHA recordkeeping?

Not if the accidents and illnesses are required to be reported under the Federal Coal Mine Health and Safety Act or the Federal Metal and Nonmetallic Mine Safety Act.

26. Following an inspection, do employees or their representatives have the right to be present at the closing conference?

No, since the employees or their representatives will have communicated with the OSHA Compliance Officer during the inspection in which they have participated. However, if employees or their representatives so request, a generally responsive discussion will be held.

27. An OSHA Compliance Officer entering a workplace must present credentials to the agent in charge. If no person in the workplace claims such a position, what is done?

After a reasonable time, the OSHA Compliance Officer will determine the person who is the agent in charge and present credentials to that person.

Standards

28. Do any of the maritime or construction standards apply to an establishment not engaged in maritime or construction activities?

No. Such standards apply only to employers in those activities. They are not standards of general applicability.

29. Whose standards prevail when both the federal and state governments have authority during the 18(h) agreement period?

Both the more stringent federal and those state standards incorporated in the 18(h) agreements are in effect.

30. What is meant by "national consensus standards"?

Those standards developed and adopted on a consensus basis by nationally recognized standards-producing organizations such as the American National Standards Institute (ANSI) and the National Fire Protection Association (NFPA).

31. How can an employer obtain a "temporary variance" from a particular standard?

The variance is available to employers and classes of employers who cannot comply with a standard by its effective date because of the unavailability of professional or technical personnel or of materials and equipment necessary for compliance. An employer must set forth the steps taken and to be taken to achieve compliance and the dates for completion of each step. Applications for temporary variances are to be filed with the Assistant Secretary of Labor for Occupational Safety and Health.

32. How can an employer obtain a "permanent variance" from a standard?

Employers and classes of employers may apply to the Assistant Secretary of Labor for Occupational Safety and Health. The applicant must demonstrate that the conditions, practices, means, methods, operations, or processes used or proposed would provide employment and places of employment that are as safe and healthful as those required by the standard from which a variance is sought.

33. If an individual believes a new standard is unjust or unnecessary, what may he or she do?

Any person adversely affected by a standard may challenge its validity within 60 days by petitioning the U.S. Circuit Court of Appeals.

34. Where no standard exists covering a particular workplace hazard, is the employer free from all responsibilities?

No. The employer must, as a general duty, furnish a place of employment that is free from recognized hazards that are causing or are likely to cause death or serious physical harm to employees.

35. How fast will requests for variances be acted upon?

OSHA must act within a reasonable time.

36. What effect do new standards have upon the Inspection Survey Guide?

The standards must be followed as stated in the Federal Register. The Inspection Survey Guide illustrates some of the important points that will be stressed in compliance inspections.

37. Why are some provisions in the initial standards advisory rather than mandatory?

Some advisory language was retained when it served to illustrate, or amplify, a mandatory provision.

38. When do the initial standards cease to be in force?

Only when amended or revoked.

39. How can a company or individual help set standards in the future?

Any interested person may submit, in writing, information requesting a new or modified standard to the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, Washington, DC 20210.

40. What provisions has OSHA made to update the standards continually?

Special groups within the OSHA Office of Safety and Health Standards are responsible for updating each of the subparts on the basis of the most recent information available.

41. Will a variance in standards granted under OSHA be valid under another act such as the Walsh-Healey Public Contracts Act, the Service Contract Act, the Construction Safety Act, or the Maritime Safety Act?

Yes.

12. When an employer offers to abate a nonserious violation in reasonable time, will a penalty be assessed?

A penalty may be proposed in these circumstances. However, the proposed penalty could be reduced 50% if the employer abates the condition within the time specified in the citation.

13. Who can represent the employer on an inspection?

Any person the employer designates may represent him or her during an inspection.

14. Is it true no penalty will be assessed if an employer cited for the first time corrects the situation in the time allotted?

No. A penalty will be proposed for a serious violation and may be proposed for a nonserious violation.

15. Can an employer obtain a temporary variance to a standard if he or she cannot absorb the cost of a particularly expensive change to come into compliance?

Yes, an employer can file a Petition for Modification of Abatement (PMA) if "uncontrollable events" or other circumstances prevent him or her from meeting the abatement date. More information on PMAs may be obtained from your Local OSHA Area Office.

16. If immediate corrections are made in a workplace, will a citation still be issued?

In general, if a violation is found, a citation will be issued.

17. After an employer has been assessed a penalty, what is the time limit for payment?

The Act does not specify any time limit for payment, once penalties become final. However, they should be "timely," and if a penalty is not contested, OSHA considers it due immediately.

18. Can an employer contest a citation, abatement date, etc., by telephone?

No. The employee must notify the Area Director *in writing* that he or she intends to contest the citation, abatement date, or proposed penalty. Such notice of intention to contest must be postmarked within 15 working days of the receipt by the employer of the notice of proposed penalty.

19. If an employee complains in writing about a hazardous working condition, how is he or she protected from employer dissatisfaction?

If an employee requests anonymity from the employer, OSHA will comply with the request. If an employer takes discriminatory action against an employee for having exercised any rights granted under the Act, including the right to file a complaint about a hazardous working condition, judicial sanctions against the employer may be invoked.

20. Will OSHA investigate all major accidents?

OSHA will not necessarily investigate all major accidents. Determinations as to which accidents shall be investigated will be made by the Area Director and the Regional Administrator. Among the factors that will be taken into consideration in making such determinations are the gravity of the accident and the availability of manpower. The following are examples of events that will be investigated if time and resources permit: 1) accidents involving previous complaints alleging imminent danger or serious conditions; 2) fatalities involving possible willful or repeated violations, or refusal to abate cited violations; 3) occurrences involving fatalities and/or injuries causing numerous employees to be hospitalized; and 4) accidents involving extensive property damage if there is a reasonable probability that one or more fatalities or serious injuries could have occurred had employees been at their workplaces.

21. How does an employer appeal a citation or proposed penalty?

The employer notifies the Area Director in writing that he or she intends to contest the citation or proposed penalty before the Review Commission. This must take place within 15 working days of the employer's receipt of the notice of proposed penalty. The employer must post notice in the establishment and give the union a copy.

22. How often will an establishment be inspected?

There is no set pattern, since the frequency of inspections depends on a number of factors. Generally, if an establishment is within a Target Industry, it is more likely to be inspected than if it were not in such an industry.

23. Will an employer's past safety record be considered when a complaint is filed?

Possibly, but only as background material to give the OSHA Compliance Officer some idea of what may be involved. Past safety records will be considered in proposing penalties.

24. Will inspections be made on a priority basis, and if so, what are the priorities?

There are four priorities: 1) catastrophes and or fatalities; 2) formal (written) complaints by employees or their representatives, 3) Target Industries; 4) a random, cross-section selection of all types and sizes of establishments in all sections of the country.

25. Who may accompany a Compliance Officer on a tour of the plant or site?

A representative of the employer and a representative authorized by the employees. In the absence of an authorized employee representative, the OSHA Compliance Officer will consult with a reasonable number of employees concerning safety and health in the workplace. Employees must be paid for time spent accompanying the OSHA Compliance Officer, and participation in other inspection-related activities such as responding to questions of the Compliance Officer or participating in the opening and closing conferences. The Compliance Officer has the authority to deny the right of accompaniment to any person whose conduct interferes with a fair and orderly inspection.

APPENDIX III: QUESTIONS AND ANSWERS ABOUT OSHA

The following pages will be helpful in answering many of your questions about OSHA. The questions are divided into three groups: Compliance; Standards; and Miscellaneous.

If you have additional questions pertaining to the Occupational Safety and Health Act, write to the publishers of this manual.

Compliance

1. **Will an OSHA Compliance Officer give advance notice before an inspection?**

   No, except in the following situations: a) in cases of imminent danger; b) when the inspection can be conducted most effectively after regular business hours; c) when necessary to assure the presence of representatives of employer and employees, or the appropriate personnel needed to aid in the inspection; d) when the Area Director determines advance notice would enhance the probability of an effective and thorough inspection.

2. **If existing safety equipment does not meet the OSHA standards, will time be made available to purchase approved equipment?**

   Any citation issued will fix a reasonable time for abatement of the alleged violation (usually 15 days renewable).

3. **Will there be an inspection if a complaint is anonymous?**

   Generally not, although the complaint will be maintained on file for future reference, or a letter noting the complaint may be sent to the employer. However, if evaluation of the complaint indicates that an imminent danger situation may be involved, an inspection will be conducted immediately.

4. **Who will establish the amount of the proposed penalty for serious violations?**

   The Area Director, after reviewing the OSHA Compliance Officer's inspection report, will prepare citations and proposed penalties where appropriate.

5. **May an employer request an inspection for educational purposes?**

   Yes, in most states OSHA offers a free consultation service where employers can request an inspection without the threat of citations or fines, providing the employer agrees to correct any violations cited. Contact your local OSHA Area Office for the consultant services available.

6. **If an employee claims an occupational illness and the company disagrees, what will OSHA do if the employee files a complaint?**

   An investigation will be conducted if the Area Director determines that there are reasonable grounds to believe an alleged violation exists. If it is determined that an

inspection is not warranted, the Director will notify the employee in writing. In that case, the employee may appeal in writing to the Regional Administrator. The employee must provide a copy of the letter to the employer, who may file a written statement in opposition. The decision of the Regional Administrator will be final and not subject to further review.

7. **Does a high injury rate increase the possibility of an inspection?**

   Yes.

8. **Does every citation necessarily carry a dollar penalty for employers?**

   Serious violations carry mandatory penalties. Nonserious violations, failure to abate a violation within the abatement period, and willful violations carry discretionary penalties. In all cases, the Act requires that due consideration be given to the size of the business, the gravity of the violation, the good faith of the employer, and the history of previous violations.

9. **What amount in monetary penalties may be levied for individual citations?**

   The amount will depend on the gravity of the violation, the good faith of the employer, the history of previous violations, and the size of the establishment. Civil penalties will be proposed for violations of the general duty clause, standards, rules, or orders promulgated under Section 6 of the Act, or any regulation prescribed pursuant to the Act. Penalties are required for serious violations and may be as much as $1,000. Penalties up to $10,000 may be proposed for willful or repeated violations. For violations that are other than serious but are not *de minimis,* penalties up to $1,000 may be proposed. Generally, all instances of the same or substantially the same violation will count as one violation for penalty purposes. If a serious violation is not abated within the period specified in a citation and no notice of contest has been filed, a penalty of $1,000 a day is levied for each day the violation continues beyond the abatement period; $100 per day for nonserious violations is levied. If a notice of contest is filed in good faith, this penalty can be proposed in a similar manner for each day the violation continues following a final order of the Review Commission affirming the citation.

10. **What is a serious violation?**

    A serious violation of a standard or of the general duty requirement exists in any workplace where there is a substantial probability that death or serious physical injury could result and the employer knew, or with the exercise of reasonable diligence should have known, of the presence of the violation.

11. **Does the Act contain penalties for employees who willfully violate reasonable safety standards?**

    No.

APPENDIX IV: OSHA & WORKERS' COMPENSATION

The law requires that employers make the workplace safe and healthful for their workers — for the very obvious reason that unsafe and unhealthful workplaces injure workers or make them sick. At bottom the OSH Act reflects the notion that employers hold a moral obligation for the well being of their workers. The act enforces this notion with heavy financial sanctions. Thus employers run the risk that they will pay substantial penalties if they permit unsafe or unhealthful conditions to persist in the workplace. But OSHA's sanctions aren't the only threat presented by unsafe or unhealthful conditions on the job site. Employers also run the risk that an injured or ill employee will qualify for workers' compensation benefits. This, too, hits the bottom line, since work comp premiums directly reflect the risk that workers face on the job.

Given these connections, it is important that safety managers understand how the work comp system works. This section of the Merritt OSHA Manual presents a brief overview of the system.

THE CHOICES

State law requires that employers cover their workers with work comp insurance in all but three states: New Jersey, South Carolina, and Texas, and New Jersey makes it so difficult for employers to opt out that, for all intents and purposes, employers in that state must buy the coverage, too.

Six states — Nevada, North Dakota, Ohio, Washington, West Virginia, and Wyoming — run "monopolistic" work comp funds. These funds serve as the only source of work comp insurance in these jurisdictions, so employers get only one choice: they must buy their insurance from the state fund. Private work comp insurers do not operate at all in these states.

In thirteen jurisdictions — Arizona, California, Colorado, Idaho, Maryland, Michigan, Minnesota, Montana, New York, Oklahoma, Oregon, Pennsylvania, and Utah — the states run work comp funds which compete for accounts with private insurers. As the decade of the 1990s began, the states of Hawaii, New Mexico and Rhode Island authorized the establishment of competitive state funds but did not immediately get them up and running. New Mexico sought to establish an innovative state-owned mutual insurer of work comp accounts. The effort ran aground in legal confusion as to whether such a concern violated the state constitution, which prevents the state from competing with private profit-making businesses.

In reality the competitive state funds operate with a competitive advantage: most pay no commissions, and they operate on a break-even basis. These conditions make it difficult for private markets to compete successfully.

All of the other states and the District of Columbia operate work comp "pools" or assigned risk funds which serve as insurers of last resort. Almost without exception the pools and assigned risk funds show disastrous financials. They take the work comp accounts that no one else wants, and they charge premiums which in no way reflect the risk. In all, this residual market, as it is known, gobbled up a 23% market share in 1990, according to the National Council on Compensation Insurance. Six short years before then, in 1984, the residual market took a 5.5% market share.

Worse, the pools and assigned risk funds set premiums at such unrealistic levels that, in 1990 alone, operating losses hit $3.5 billion, according to NCCI. The states, of course, fund these losses by digging into the pockets of insurers in the voluntary market, effectively making them shoulder some of the risk of the accounts in the pools and assigned risk funds whether they want to or not. To balance out that eye-popping $3.5 billion loss in 1990, for instance, the states assessed private insurers 15 cents for every dollar in work comp premium they wrote in the states in question.

As safety managers already know, this really means that the costs fall on employers, since insurers in the voluntary market have no choice but to pass them on to their customers. Their only other choice is to stop writing work comp accounts in the state in question. As time passes, insurers take this option more and more often, setting in motion a spiral which makes it ever harder for employers to get work comp coverage at a decent price.

For that matter, more and more employers seek to opt out of this mess by self-insuring (concerning which, see below). Practices vary, and the courts have yet to speak definitively on this question, but in general self-insurers escape assessments for state pool and assigned risk fund deficits.

Employers, then, may buy work comp insurance from:

A monopolistic state fund

A competitive state fund

A state pool or assigned risk plan

A private market carrier.

If none of these alternatives fits a given employer's special needs, the employer has one final option — to self insure. The balance of this article discusses the basics of private market insurance and the essential elements of self-insurance.

THE BASICS OF PRIVATE MARKET INSURANCE

Safety managers know that job-related injuries and illnesses can be serious. The work comp system seeks to ensure that an injured or ill worker receives prompt medical attention with "first dollar" benefits — ie., at no cost to the worker. It compensates the worker for lost wages and seeks to rehabilitate and return the worker to the job as quickly as possible. It provides for death benefits for the dependents of workers killed on the job. In exchange for these benefits, workers give up the right to sue their employers over the conditions which gave rise to the injury or illness (although they retain the right, under federal law, to inform OSHA of any conditions which violate OSHA standards). In effect, then, workers get the attention they need in order to get back to work, and employers in turn free themselves from protracted, costly court fights over the causes of the injury or illness.

That much is what the framers of the work comp system had in mind, at any rate, as the states began putting their work comp programs in place during the early years of this century. In recent years the actual work comp system has come to look less and less like the original.

For one thing, the relationship between employer and the ill or injured worker has become increasingly adversarial, not unlike the relationship between many employers and OSHA. The legal system has injected itself into the relationship between employer and worker, playing an

ever greater role in an arena designed to preclude the need for lawyers in the first place; indeed, the legal profession has developed what amounts to a new specialty — the lawyer who works solely on work comp disputes. Thus it becomes ever more likely that a job-related illness or injury will subject the employer to protracted court fights and big bills from the lawyer. The worker, meanwhile, awaits full settlement, and may or may not get back to the job in rapid fashion. To the extent that the legal climate surrounding work comp resembles that of tort liability, the worker may never get full settlement. Indeed, when the worker falls victim to the vagaries of the court system, the process becomes more like a lottery than an attempt to see that justice is done. Winners win big, and losers may get nothing at all. In addition, as mentioned earlier, OSHA may enter the picture if the condition which gave rise to the worker's illness or injury violated agency standards.

For another, the medical profession has shown itself wholly unable to control the costs of services provided to anyone, especially ill or injured workers. Safety directors may find it interesting to know that work comp medical costs inflate at a far higher rate than medical costs in general. In 1989 the Workers' Compensation Institute issued a study of medical costs covering the years 1965 to 1985. During that period medical costs associated with work comp claims increased by a whopping 14.7% per year. In contrast, over the same period medical costs rose 9.8% per year across the board.

There is no doubt that fraud plays a part here, involving both workers and health professionals. But fraud cannot account for the whole mess. Instead, as work comp costs soar, more and more medical professionals — physicians, nurses, physical therapists — devote themselves solely to work comp practices, just like lawyers. It is difficult to account for the extreme inflation in work comp medical costs without suspecting that those health professionals who devote themselves exclusively to work comp practices simply know a good thing when they see it.

Whatever its source, the inflation in medical costs subverts the work comp insurance market in a subtle way. In the insurance industry your income and outgo are supposed to balance out. Thus premiums are supposed to equal losses, and you make your profit from investing capital. Now, the work comp system assumes that wages and medical costs will inflate at the same rate, and so long as they do so, insurers encounter no difficulty in underwriting work comp risks at a profit.

This assumption is crucial. It is also wrong. Premiums directly reflect wages; as wages go up, so do premiums. But an insurer's losses directly reflect medical costs, which spiral out of control. Since 1981, according to the National Council on Compensation Insurance, wages have increased 3% per year. Medical costs, as shown above, have inflated at a much higher rate. When medical costs rise at a faster rate than wages, premiums get left in the dust. Thus an insurer's income — namely premiums — doesn't come close to equaling its outgo — namely medical costs. The bottom line? Horrendous losses. In 1990, work comp brought in 14% of the property/casualty industry's premiums and accounted for 26% of its underwriting losses. In the same year the work comp combined ratio approached 120. This means that for every dollar of premium, the industry paid out $1.20 in claims. The combined ratio is supposed to measure profitability. In the work comp insurance industry, it measures losses.Safety managers who deal with their employer's work comp insurance know that the turmoil in the work comp market stems from yet another source: politics. The work comp system varies from state to state, and the state legislatures find it almost impossible to resist the temptation to make work comp benefits more and more generous. In a free market higher benefits would simply mean higher

premiums, of course, and this would present insurers with no insurmountable problem; they would simply underwrite the bigger risk with bigger premiums.

The big wrinkle on this prune, however, is that in most states the markets aren't free. Indeed, most states control premiums along with benefits. In addition, employers consider work comp premiums excessive already, and they resist paying more no matter what new benefits the state legislatures add, and no matter what pressures insurers face in the form of medical cost inflation.

Thus the states want insurers to cover an ever expanding array of illnesses and injuries, but they don't want them to pass the cost of doing so along to employers. All of which serves only to increase the squeeze on the work comp insurance market. Insurers cannot set premiums to reflect those items which directly affect their bottom line: wages and losses.

THE OPTIONS FOR EMPLOYERS

Employers and their insurers continue to seek new ways to make their mutual problems less intractable, with varying degrees of success. As safety managers know, however, no matter what employers and insurers do, the cost of providing work comp coverage directly reflects the degree to which employers control job-related illnesses and injuries. An employer's relations with OSHA reflect the same items, by and large, and this is where safety managers can play an especially important role.

In reality, if employers don't get their work comp coverage from the state, they have only two choices. They can buy coverage from a private carrier or they can self insure. To one degree or another, everything else that employers and insurers have tried lies somewhere along the continuum between these two extremes.

The traditional work comp insurance package works much like any other insurance contract. In exchange for the premium, the insurer shoulders the risk of claims. The traditional work comp insurance contract contains two essential elements: the work comp section and the employer liability section. The first obligates the insurer "to pay promptly when due" the benefits imposed by the work comp laws in the states in which the coverage applies. This section entails the payment of claims for medical costs and lost wages. The second section covers employers for liabilities arising from job-related injuries to workers. Essentially this section obliges the insurer to pay third party damages, damages assessed for care and loss of services, consequential injuries to the family members of an injured worker, and so on.

In the early days of work comp insurance, most employers bought total coverage of this sort from private carriers. At present, fewer and fewer do because fewer and fewer can find it or afford it when they do find it. The turmoil in the market forces insurers to limit the business they do from state to state, and from class to class. Many don't write certain classes no matter what the state. Many don't write business in certain states no matter what the class. To make things even worse, many of the big property/casualty insurers write work comp only when they get the rest of the package, too.

Still, private insurers — the "voluntary market," in the parlance of state regulators — haven't abandoned the marketplace altogether. And as time goes by they help the market cope with the pressures that make things hard for everybody.

Among other alternatives, private insurers offer employers work comp programs with:

large deductibles

dividend plans"

retrospective" rating elements

"managed care" programs

and extensive safety programs.

In addition, the private market sells claims and administrative services to self-insurers, relieving them of the enormous paperwork burdens that come with self-insuring programs. The private market also backs self-insurance programs with reinsurance coverage.

LARGE DEDUCTIBLES

Work comp deductible programs allow employers to "retain" — or remain responsible for — a certain part of their work comp risk. In a sense these programs function like the deductibles on private health coverage sold to individuals and families. Safety managers know that to the employer, the advantage of a deductible program is exactly the same as the advantage of a deductible on a private health insurance package: it lowers the premium, and the bigger the deductible, the lower the premium. The employer remains responsible for all costs to the deductible limit, after which the insurance kicks in. Deductibles range all over the map, from $500,000 or even less to many millions of dollars, depending on the size of the employer and the employer's appetite for risk.

Large deductible programs carry an obvious incentive to control losses — another area in which safety managers can play an important role. The employer remains responsible for all losses up to the deductible, so every penny paid out in work comp benefits comes out of the employer's bottom line. Thus the employer has every reason to take safety seriously and to see to it that workers don't fall victim to injury or illness. Large deductible programs have a way of making employers take OSHA's safety and health standards seriously, too. Safety managers find it much easier to sell senior management on the wisdom of complying with the spirit, not just the letter, of the OSH Act when the employer already has a large-deductible work comp program in place.

Employers with large-deductible work comp programs commonly devise extensive safety programs covering every aspect of worksite job operations posing hazard to safety and health. The most effective of these programs often set out more stringent requirements than OSHA's own safety and health standards, with which they share the same aim: to prevent job-related injury and sickness. The importance of the safety director under such programs is obvious.

"RETROS"

With retrospective rating programs insurers essentially fix their premiums in arrears, not in advance. To be sure, the insurer does not extend the insurance for, say, a year and forego collecting a premium until thereafter. Instead the employer pays a basic premium up front, with a guarantee that, no matter what the losses, the premium will not exceed a certain maximum. The insurance company monitors losses, and at the end of the term fixes the final premium based on what the losses come to. Most commonly, at the end of the term the employer gets a notice for additional premium due. If, on the other hand, the employer's safety programs have born special fruit, the employer may get something back from the insurer.

In either case the retro plan retains the special element that makes it an insurance plan — namely that the insurer, not the employer, bears the risk that losses will exceed the maximum premium. The employer bears only the risk that the premium will vary between the minimum and the maximum. The employer does not bear the risk of loss beyond the maximum premium, no matter how great the actual losses.

DIVIDENDS

Dividend contracts look something like retro programs except that the insurer charges a fixed premium and returns a dividend if losses fall below expectations. The employer gets no dividend, of course, if losses exceed expectations. The contract specifies when dividends will be paid — commonly some months after the contract year, so as to give the insurer plenty of time to measure losses.

Insurers often couple dividend contracts with strong safety programs, fielding teams of safety experts to review work practices and suggest ways to make things safer and more healthful. Safety managers team up with these safety experts on the jobsite. The record of these programs is spotty, however, and it is important to keep in mind that the employer's interests and the insurer's don't always coincide. The best safety teams really do improve safety, in which case the safety manager's work can be decisive. Other safety teams seek only to avoid losses to the insurer, which can be a very different item.

Successful dividend programs depend heavily on careful underwriting as well. The best of these programs can be very attractive to the employer, returning dividends amounting to 40% or more of the premium. The employer loses the use of this money in the interim, of course, and among large employers this can prove a decisive factor.

MANAGED CARE PROGRAMS

Managed care programs become increasingly common with every year. They vary in form and effectiveness but share the same goal: to control medical care costs by injecting the insurer into the relationship between patient and health care provider. This effort stands out as the truly interesting, and problematic, element of managed care programs. Physicians always considered their relations with patients to be sacrosanct; this privity was an item of the professional canon. Managed care programs make the insurer a player in the relationship between patient and physician — and not a passive one.

Some managed care programs set up mechanisms to review medical treatment plans, often in advance of the treatment itself (so long as no emergency exists). Thus when a physician suggests surgery for a patient with, say, a back ailment, the insurer reviews the medical record and, often using a panel including physicians, passes on the advisability of the surgery, not to mention the probable cost. The panel may approve the surgery routinely. It may suggest some less costly alternative. It may refuse to approve the surgery altogether as being unnecessary. Whatever the outcome, the effect is to make the insurer a party to the decision to do the surgery — sometimes the most important party.

Preferred provider networks stand as another variation on this theme. Insurers contract with physicians, hospitals and other health providers to serve the insurer's policyholders at reduced rates. The advantage to the health professional is a guaranteed stream of patients. The insurer gains a reduction in costs — in theory, at least. Some studies suggest that these programs don't

give insurers the reductions they envision. In part the problem may arise from the fact that medical practices vary so much from region to region and even from hospital to hospital in the same region. Standard protocol in one hospital, for instance, may call for some breast cancer surgery to be done with local anesthesia and on an outpatient basis. In another hospital in the same area protocol for the same surgery calls for general anesthesia and at least one night's stay in the hospital. Such differences in practice make for very big differences in cost, of course, and insurers don't always know what to do about them. The variations become even greater when insurers compare medical costs in rural and metropolitan areas.

Computers, on the other hand, enable insurers to monitor hospital costs with considerable efficacy. Despite the obvious legal incentives to the contrary, hospitals are often the sloppiest of record keepers. They double charge and overcharge almost routinely. They fail to charge for services they do perform. Worse, they charge for services they don't perform; they even charge one patient for services performed on behalf of the patient in the next bed. And they charge one fee, for example, for an injection if given by a nurse and altogether another for the same injection if given by a physician.

Computer monitoring programs enable insurers to track patients and services and to red-flag those charges that don't fit. Some insurers report startling savings from these programs, shaving 20% or more from the bills they get from hospitals. Insurers see great promise in these programs.

SAFETY PROGRAMS

The safety manager who oversees a company's OSHA compliance efforts has no trouble understanding that safety programs offer the greatest promise in controlling work comp costs. With OSHA, the whole idea is to prevent accidents and illnesses. Ditto with work comp safety programs, which seek to organize the workplace so as to head off accidents and job-related illnesses in the first place. Work comp insurers take on even risky classes when they can predict the risk. And they can predict the risk with great accuracy when, backed by onsite management, they can analyse the workplace and make changes designed to lessen risk.

The first trick, of course, is to get management backing; those who oversee OSHA compliance know how difficult this can be. The second trick is to find an insurer with real expertise in a given business. It does no good to call in a safety programmer whose expertise lies elsewhere.

SELF INSURANCE

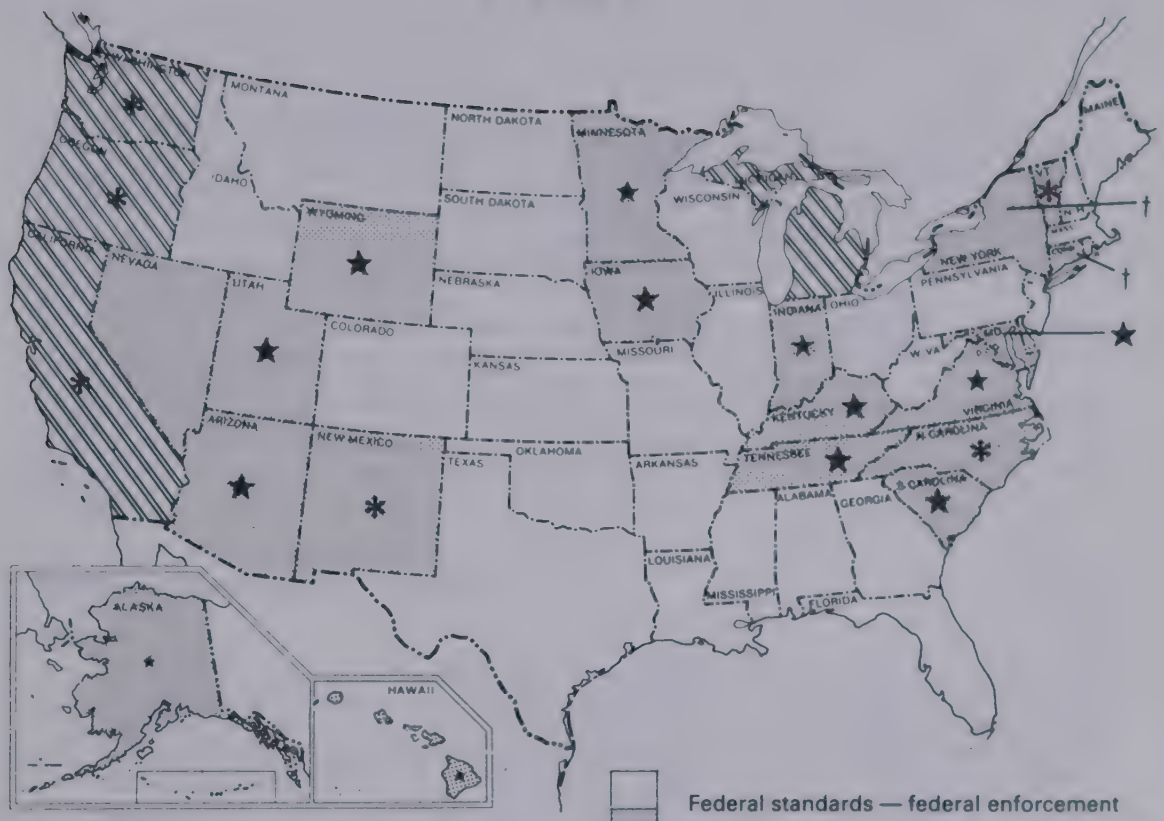
If all else fails, employers can always self-insure — and as time passes, more and more do, especially large employers. In 1988, self-insurers took 40% of the work comp market, and their share continues to increase. Credit goes to the turmoil in the work comp market, in part; many employers simply can't buy work comp coverage at all. Credit also goes, however, to the considerable financial advantages self-insurers enjoy under current tax law.

To protect themselves from the obvious liability risks, self-insurers establish and capitalize a captive insurance subsidiary to bear the risk. The parent company pays a premium just as it would to any insurer, and the captive insurer administers and pays claims. It also gets to invest the capital, with obvious bottom-line advantages to the parent company.

The Internal Revenue Service looks on captive insurers with a jaundiced eye. Over the years the IRS has sought strenuously to outlaw them, but in general the courts have ruled against the government so long as certain conditions obtain. Most important, the captive insurer must truly shoulder the risk of loss. It cannot look to the parent company to bail it out of trouble. Captive insurers have trouble meeting this test when they handle only the business of the parent company, and when the IRS decides to attack, it often targets such arrangements.

Captive insurers stand a better chance of passing muster when they take on insurance risks from other, unrelated sources. Allstate, a unit of Sears, insures the parent company, but it also sells a wide variety of commercial lines property/casualty contracts to other businesses, plus auto, homeowner and life coverages to individuals. It was this ancillary business which enabled Allstate to withstand one of the IRS's most concerted legal attacks in an important tax court ruling in 1991. The ruling controverted the IRS's long-held contention that parent companies cannot deduct the premiums paid to captive insurers on the grounds that both units constitute members of the same "economic family."

The Allstate ruling, coupled with several others issued in recent years, bodes well for self-insurers. The tactic holds special appeal for large employers, but smaller employers will find ways to use it as well. Large employers hold the capital it takes to set up a captive insurer, and they have access to the necessary legal and actuarial talent. Smaller employers will follow by banding together into formal associations to achieve the same end. In all, given the growth in self-insurance, and given the huge market share already held by the residual market, private insurers working the work comp market will become rarer and rarer birds.



- ☐ PUERTO RICO*
- ☐ SAMOA
- ☐ GUAM
- ☐ VIRGIN ISLANDS★

Federal standards — federal enforcement

State plan — state enforced federal standards

State plan — state enforced state standards

*State plan certified

★State plan has final approval

On-site consultation now available in all jurisdictions

FEDERAL OSHA AND STATE PLANS JURISDICTIONS

The above map represents the current status of jurisdictional areas for applicable OSHA or state regulations, inspections, and enforcement. All of the states are monitored by OSHA to determine state plan qualification. State plans must be judged "at least as effective as" the federal program in order to be approved. A state plan may receive OSHA approval by demonstrating it will meet all requirements within three years. After completing these steps and operating its program at a fully effective level for at least one year, federal enforcement will end in the areas covered by the state plan. OSHA then continues its monitoring to determine when the plan should be certified and when it should receive final approval.

† Connecticut and New York — state plan covers employees of state only; all other employees are under federal OSHA jurisdiction.

ALASKA

ALASKA STATE PLAN OVERVIEW

The Alaska state occupational safety and health plan was approved July 31, 1973, declared operational as of June 5, 1975 and was certified effective September 9, 1977 as having completed its developmental steps. After an evaluation determined the plan was at least as effective as the federal plan, OSHA granted final approval to the Alaska plan on September 26, 1984, and stopped enforcing the federal occupational safety and health standards. The plan is enforced by the Alaska Department of Labor.

All places of employment (with one or more employees) in Alaska are covered by the plan except private sector maritime employment, worksites on navigable waters, private employers in the Metlakatla Indian community, and public employees and employers.

The state plan closely follows federal OSHA standards, and includes construction and agricultural standards. Special provisions require every employer to develop and implement an accident prevention program and inform employees about workplace toxic and hazardous substances.

Description of the Plan as Initially Approved

1952.240

(a) The Department of Labor is the state agency designated by the governor to administer the plan throughout the state. The plan defines the covered occupational safety and health issues as defined by the Secretary of Labor in §1902.2(c)(1) of this chapter under four major codes for general safety, industrial housing, electrical hazards, and occupational health and environmental controls. The plan also includes vertical special industry codes for construction, wood products, petroleum, and fishing. Appendix G of the plan contains a timetable for adoption of the standards which requires from six to 36 months for completion of the standard-setting process with most of the standards to be adopted within six months of the effective date of the grant.

(b) (1) The plan included draft legislation which has been passed by the state legislature and signed by the governor amending Chapter 18 of the Alaska statutes. Under the legislation the Department of Labor has full authority to enforce and administer laws respecting safety and health of employees in all workplaces of the state, including coverage of public employees, with the exceptions of maritime workers in the area of exclusive federal jurisdiction; employees of the United States; employees protected by state agencies under the Atomic Energy Act of 1954; and employees whose working conditions are regulated by federal agencies other than the U.S. Department of Labor.

(2) The legislation brings the plan into conformity with the requirements of Part 1902 of this chapter in areas such as procedures for granting or denying permanent and temporary variances to standards by the commissioner; protection of employees from hazards; promulgation of standards by the commissioner prescribing requirements "at least as effective" as the requirements for federal standards including medical examinations and monitoring and measuring of hazards; imminent danger abatement by administrative order and court injunction; protection of employees against discharge or discrimination in terms or conditions of employment by filing complaints with the commissioner who will seek court action through the state attorney general and adequate safeguards to protect trade secrets.

(3) The legislation provides for inspections, including inspections in response to complaints; gives employers and employee representatives an opportunity to accompany inspectors in order to aid inspections and provides for payment to employees for time spent in aiding an inspection; notification of employees or their representatives when no compliance action is taken as a result of an alleged violation, including informal review; notification of employees of their protections and obligations through legislative requirements on posting; provision for prompt notice to

employers and employees of alleged violations of standards, and abatement requirements, through the issuance and posting of citations; a system of sanctions against employers for violations of standards; employer right of review to the Occupational Safety and Health Review Board; and employee participation in the review procedure with compensation for time spent by the employee.

(c) Included in the plan is a statement of legal opinion that the law, which was supported by the governor in accordance with the requirements of Part 1902 of this chapter, is consistent with the constitution and laws of Alaska. The plan sets out goals and provides a timetable for bringing it into full conformity with Part 1902 of this chapter at the end of three years after commencement of operations under this plan. Personnel will be employed under the existing state merit system and the voluntary compliance program for on-site consultation meets the conditions set forth in the Washington decision (38 F.R. 2421). The plan also includes the State Administrative Procedure Act which authorizes the commissioner to promulgate emergency temporary standards and issue rules and regulations necessary for the implementation of the safety and health law.

(d) The plan includes the following documents as of the date of approval:

(1) The plan document and appendices A through V.

(2) Alaska legislation as enacted amending Chapter 18 of the Alaska statutes.

(3) Letters from the Commissioner of Labor dated May 25, 1973, June 15, 1973, and July 10, 1973.

Developmental Schedule

1952.241

The Alaska plan is developmental. The schedule of developmental steps follows:

(a) Promulgation of occupational safety and health standards, as effective as corresponding federal standards promulgated under Chapter XVII of Title 29, Code of Federal Regulations by September 1976.

(b) A compliance operations manual for the guidance of compliance personnel will be developed and printed by February 1, 1974.

(c) A management information system (MIS) will be developed by October 1, 1974.

(d) An interim training schedule (Appendix M) will be initiated by April 1, 1974. An extended training plan of substantially permanent form will be developed and adopted by October 1, 1976.

(e) Complete hiring of industrial health staff by October 1, 1976.

(f) Provide for an Industrial Health Laboratory capacity by October 1, 1976.

(g) Adoption of the following regulations by January 30, 1975:

(1) Recordkeeping & reporting;

(2) Variances;

(3) Exceptions to the prohibitions against advance notice (such exceptions to be no broader than those contained in 29 CFR Part 1903);

(4) Clarification of the appropriate parties for employers to notify in order to file a notice of contest;

(5) A definition of imminent danger that mirrors the federal definition;

(6) A regulation to allow affected employees to participate as parties in hearings.

Completed Developmental Steps

1952.242

(a) Alaska completed its interim training program by April 1, 1974, and has developed and adopted an extended training program by October 1, 1976.

(b) Alaska has developed and implemented a manual management information system by October 1, 1974.

(c) The Alaska safety and health poster for private and public employees was approved by the Assistant Secretary on September 28, 1976.

(d) Alaska has completed hiring of its industrial health staff by October 1, 1976.

(e) Alaska has provided for an industrial health laboratory capacity by October 1, 1976.

(f) Alaska has adopted regulations covering inspections, citations, and proposed penalties, Alaska Occuptional Safety and Health Review Board procedures; recording and reporting occupational injuries and illnesses; variances; and consulting and training which were approved by the Assistant Secretary on August 2, 1977.

(g) Alaska had developed a compliance manual which is modeled after the federal field operations manual and was approved by the Assistant Secretary on August 2, 1977.

(h) The Alaska occupational safety and health plan was certified, effective September 9, 1977, as having completed on or before October 1, 1976, all developmental steps specified in the plan as approved on July 31, 1973.

Final Approval Determination

1952.243

(a) In accordance with section 18(e) of the Act and procedures in 29 CFR Part 1902, and after a determination that the state met the "fully effective" compliance staffing benchmarks as established in 1980 in response to a court order, and was satisfactorily providing reports to OSHA through participation in the federal-state unified management information system, the Assistant Secretary evaluated actual operations under the Alaska state plan for at least one year following certification of completion of developmental steps. Based on the evaluation report for FY 1983 and available FY 1984 data, and after opportunity for public comment and an informal public hearing, the Assistant Secretary determined that in actual operations, the state of Alaska occupational safety and health program is at least as effective as the federal program in providing safe and healthful employment and places of employment and meets the criteria for final state plan approval. Accordingly, the Alaska plan was granted final approval and concurrent federal enforcement authority was relinquished effective September 26, 1984.

(b) The plan covers all activities of employers and all places of employment in Alaska except: private sector maritime employment, operations of private sector employers within the Metlakatla Indian community on the Annette Islands, and worksites located on the navigable waters including artificial islands.

(c) Alaska is required to maintain a state program which is at least as effective the federal program, to submit plan supplements in accordance with 29 CFR Part 1953, to allocate sufficient safety and health enforcement staff to meet the benchmarks for state staffing established by the U.S. Dept. of Labor, or any revisions to those benchmarks, and to furnish such reports in such form as the Assistant Secretary may from time to time require.

Level of Federal Enforcement

1952.244

(a) As a result of the granting of final approval to the Alaska plan, occupational safety and health standards which have been promulgated under section 6 of the Act do not apply with respect to issues covered under the Alaska plan. This determination also relinquishes concurrent federal OSHA authority to issue citations for violation of such standards under sections 5(a)(2) and 9 of the Act; to conduct inspections and investigations under section 8 [except those necessary to evalute the plan under section 18 or other inspections, investigations, or proceedings necessary to carry out federal responsibilities not pre-empted by section 18(e)]; to conduct enforcement proceedings in contested cases under section 10; to institute proceedings to correct imminent dangers under section 13; and to propose civil penalties or initiate criminal proceedings for violations of the federal Act under section 17. The Assistant Secretary may retain jurisdiction over any proceeding commenced under section 9 or 10 before September 26, 1984.

(b) In accordance with section 18(e), final approval relinquishes federal OSHA authority only with regard to occupational safety and health issues covered by the Alaska plan. OSHA retains full authority over issues which are not subject to state enforcement under the plan. Thus, federal OSHA retains its authority relative to safety and health in private sector maritime activities and will continue to enforce all provisions of the Act, rules or orders, and all federal standards, current or future, specifically directed to maritime employment (29 CFR Part 1915, shipyard employment; Part 17, marine terminals; Part 1918, longshoring; and Part 1919, gear certification) as well as provisions of general industry standards appropriate to hazards found in these employments. Federal jurisdiction will also be retained over marine-related private sector employment at worksites on the navigable waters such as floating seafood processing plants, marine construction, employments on artificial islands and diving operations in accordance with section 4(b)(1) of this Act. Federal jurisdiction is also retained for private sector worksites located within the Annette Islands Reserve of the Metlakatla Indian community and with respect to federal government employers and employees.

(c) Federal authority under provisions of the Act not listed in section 18(e) is not affected by final approval of the plan. Thus, for example, the Assistant Secretary retains his authority under section 11(c) of the Act with regard to complaints alleging discrimination against employees who exercise any right afforded to them by the Act, although such complaints may be referred to the state for investigation. The Assistant Secretary also retains the authority under section 7 of the Act to promulgate, modify, or revoke occupational safety and health standards which address the working conditions of all employees, including those in states which have received a final approval determination, although such standards may not be federally applied. In the event that the state's 18(e) status is subsequently withdrawn, and federal authority reinstated, all federal standards including any standards promulgated or modified during the 18(e) period would be federally enforceable in that state.

(d) OSHA will continue to monitor the operations of the Alaska state program to assure that the provisions of the state plan are substantially complied with and that the program remains at least as effective as the federal program. Failure by the state to comply with its obligations may result in the revocation of the final determination under section 18(e), resumption of federal enforcement and/or proceedings for withdrawal of plan approval.

Where the Plan May Be Inspected

1952.245

A copy of the principal documents comprising the plan may be inspected and copied during normal business hours at the following locations: Office of State Programs, Occupational Safety and Health Administration, U.S. Dept. of Labor, 200 Constitution Avenue, NW., Room N3476, Washington D.C. 20210; Regional Administrator, Occupational Safety and Health Administration, U.S. Dept. of Labor, Federal Office Building, Room 6003, 909 First Avenue, Seattle WA 98174; and Office of the Commissioner, Alaska Dept. of Labor, 1111 W. 8th St., Room 306, Juneau AK 99802.

Changes to Approved Plans

1952.245

(a) The following Alaska plan changes were approved by the Assistant Secretary;

(1) The state submitted a revised field operations manual patterned after and responsive to modifications to the federal field operations manual in effect February 11, 1985 which superseded its earlier approved manual. The Assistant Secretary approved the manual on October 24, 1985.

(2) The state submitted an industrial hygiene technical manual patterned after and responsive to modifications to the federal manual in effect October 29, 1984. The Assistant Secretary approved the manual on October 24, 1985.

(3) The state submitted an inspection scheduling system patterned after and responsive to the federal system in effect on October 29, 1984. The Assistant Secretary approved the supplement on October 24, 1985.

(4) The state submitted an amendment to its legislation and field procedures which provided for issuance of an onsite notice of violations which serves to require correction of other than serious violations in lieu of a citation. The Assistant Secretary approved these changes on October 24, 1985.

(5) The state submitted several changes on its administrative and review rules concerning personal sampling, ex parte warrants, petition to modify abatement dates, withdrawal of contest, recordkeeping penalties and exemptions, exemption from scheduled inspections after consultation, renaming the division of the state agency directly enforcing standards, and the address for filing contest. The Assistant Secretary approved these changes on October 24, 1985.

ARIZONA

ARIZONA STATE PLAN OVERVIEW

The Arizona state occupational safety and health plan received approval November 5, 1974 and was certified as having completed developmental steps on September 18, 1981. The Industrial Commission of Arizona enforces the state standards.

The plan's standards are practically identical to federal OSHA regulations, including construction and agriculture, with the addition of elevator and boiler pressure standards adapted from ANSI (the American National Standards Institute) and ASME (the American Society of Mechanical Engineers) codes, and personnel hoist standards also obtained from ANSI.

All employments except the maritime industry, household domestic labor, U.S. government employees, and those employees whose safety is regulated by another federal agency other than the Department of Labor are covered.

Description of the Plan as Initially Approved

1952.350

(a) (1) The plan identifies the Arizona Industrial Commission, Division of Occupational Safety and Health, as the state agency designated to administer the plan throughout the state. It adopts the definition of occupational safety and health issues expressed in §1902.2(c)(1) of this chapter. The state intends to adopt all federal standards except those found in 29 CFR Parts 1915, 1917 and 1918 (ship repairing, shipbuilding, shipbreaking and longshoring) and those subparts of Parts 1910 and 1926 pertaining to industries which are not applicable to Arizona. In addition, the state intends to enforce elevator (ANSI) and boiler pressure vessel (ASME) standards for which there are no federal counterparts.

(2) The plan provides a description of personnel employed under a merit system; the coverage of employees of political subdivisions; procedures for the development and promulgation of standards, including standards for the protection of employees against new and unforeseen hazards; and procedures for the prompt restraint or elimination of imminent danger situations.

(b) (1) The plan includes legislation enacted by the Arizona legislature during its 1974 legislative session to bring it into conformity with the requirements of Part 1902 of this chapter. Under the legislation the Industrial Commission will have full authority to enforce and administer laws respecting the safety and health of employees in all workplaces of the state.

(2) The legislation is intended, among other things, to assure inspections in response to employee complaints; give employer and employee representatives an opportunity to accompany inspectors in order to aid inspections; notification of employees or their representatives when no compliance action is taken as a result of alleged violations; notification of employees of their protections and obligations; protection of employees against discharge or discrimination in terms and conditions of employment; adequate safeguards to protect trade secrets; sanctions against employers for violations of standards and orders; employer right of review to an Occupational Safety and Health Review Board and then the courts, and employee participation in review proceedings. The plan also proposes a program of voluntary compliance by employers and employees, including a provision for on-site consultation. The state's consultation program should not detract from its enforcement program and the state has given assurances that it will meet the conditions set forth in the Washington Decision (38 FR 2421, January 26, 1973).

(c) The Arizona plan includes the following documents as of the date of approval:

(1) The plan description documents, in two volumes.

(2) A copy of the enabling legislation and enacted by the state legislature in its 1974 session.

(3) Letters from Donald G. Wiseman, Director of the Division of Occupational Safety and Health of the Arizona Commission to Barry J. White, Associate Assistant Secretary for Regional Programs on October 15, 18, and 24, 1974 submitting information, clarifications, and revisions on several issues raised during the review process, including proposals to be submitted to the Arizona legislature during its 1975 session.

Developmental Schedule

1952.351

The Arizona state plan is developmental. The following is the developmental schedule as provided by the plan:

(a) Development of a complete management information and control system by July 1, 1976.

(b) The formulation and approval of inter-agency agreements with the Arizona Atomic Energy Commission, the State Health Department and the Arizona Corporation Commission by March 1, 1975.

(c) Promulgation of variance regulations by July 1, 1977.

(d) The promulgation of recordkeeping regulations by March 1, 1975, but full implementation of these regulations will not be until July 1, 1976.

(e) The submission of legislative amendments to the Arizona legislature during its 1977 session.

Completed Developmental Steps

1952.352

(a) Implementation of the Arizona occupational safety and health program began on March 1, 1975.

(b) Interagency agreements between the Arizona Industrial Commission and the Arizona Department of Health Services were finalized on November 7, 1974, and March 20, 1975.

(c) Regulations concerning inspections, citations and proposed penalties and the rules of procedure for contests before the governor's review board were promulgated on February 28, 1975.

(d) Recordkeeping and reporting regulations were promulgated on March 1, 1975; however, these regulations will not be applicable to public employers until January 1, 1977.

(e) The universe file system for the inspection scheduling system was completed and implemented on March 12, 1976.

(f) An interagency agreement was entered into between the Corporation Commission of Arizona and the Industrial Commission on May 7, 1976 and became effective May 10, 1976.

(g) In accordance with the requirements of §1952.10, the Arizona state poster was approved by the Assistant Secretary on July 22, 1976.

(h) Arizona occupational safety and health standards comparable to federal standards in effect as of July 28, 1974, were promulgated on February 28, 1975, and were approved by the Regional Administrator effective August 6, 1976.

(i) Regulations concerning variances were promulgated on November 16, 1977 and approved on November 13, 1980.

(j) Regulations concerning discrimination complaints were promulgated on September 22, 1977 and approved on November 13, 1980.

(k) Legislative amendments required to bring the Arizona occupational safety and health law into conformity with federal requirements were enacted effective August 27, 1977.

The Arizona occupational safety and health plan was certified, effective September 18, 1981 as having completed all developmental steps specified in the plan. This certification attests to structural completion but does not render judgement on adequacy of performance.

Compliance Staffing Benchmarks

1952.353

Under the terms of a 1978 court order, compliance staffing levels necessary for a "fully effective" enforcement program were required to be established for each state operating an approved state plan. In September, 1984, Arizona in conjunction with OSHA completed a reassessment of the levels initially established in 1980 and proposed revised compliance staffing benchmarks of nine safety and six health compliance officers. After opportunity for public comment and service on the AFL-CIO, the Assistant Secretary approved these revised staffing requirements on June 20, 1985.

Final Approval Determination

1952.354

(a) After a determination that the state met the "fully effective" compliance staffing benchmarks as revised in 1984, and that the state was satisfactorily providing reports to OSHA through participation in the federal-state unified management information system, the Assistant Secretary evaluated actual operations under the state plan for at least one year following certification of completion of developmental steps. Based on the evaluation report and after opportunity for public comment, the Assistant Secretary determined that in operation, the state of Arizona's occupational safety and health program is at least as effective as the federal program in providing safe and healthful employment and places of employment and meets the criteria for final state plan approval. Accordingly, the Arizona state plan was granted final approval and concurrent federal enforcement authority was relinquished effective June 20, 1985.

(b) The plan covers all activities of employers and all places of employment in Arizona except for private sector maritime, copper smelters, and Indian reservations.

(c) Arizona is required to maintain a state program which is at least as effective as the federal program; to submit plan supplements; to allocate sufficient safety and health enforcement staff to meet benchmarks for state staffing established by the U.S. Dept. of Labor, or any revision to those benchmarks; and to furnish such reports in such form as the Assistant Secretary may from time to time require.

Level of Federal Enforcement

1952.355

(a) As a result of the granting of final approval to the Arizona plan effective June 20, 1985, occupational safety and health standards which have been promulgated under section 6 of the Act do not apply with respect to issues covered under the Arizona plan. This determination also relinquishes concurrent federal OSHA authority to issue citations for violation of such standards under section 5(a)(2) and 9 of the Act; to conduct inspections and investigations under section 8 [except those necessary to conduct evaluation of the plan under section 18(f) and other inspections, investigations, or proceedings necessary to carry out federal responsibilities not preempted by section 18(e)]; to conduct enforcement proceedings in contested cases under section 10; to institute proceedings to correct imminent dangers under section 13; and to propose civil penalties or initiate criminal proceedings for violations of the federal act under section 17. The Assistant Secretary retains jurisdiction under the above provision in any proceeding commenced under section 9 or 10 before June 20, 1985.

(b) Final approval relinquishes federal OSHA authority only with regard to occupational safety and health issues covered by the Arizona plan. OSHA retains full authority over issues which are not subject to state enforcement. Thus federal OSHA retains its authority relative to safety and health in private sector maritime activities and will continue to enforce all provisions of the Act, rules or orders, and all federal standards, current or future, specifically directed to private sector maritime employment (29 CFR Part 1915, shipyard employment; Part 17, marine terminals; Part 1918, longshoring; and Part 1919, gear certification) as well as provisions of general industry standards appropriate to hazards found in these employments, in copper smelters, and within Indian reservations. Federal jurisdiction is also retained with respect to federal government employers and employees. In addition, any hazard, industry, geographical area, operation or facility over which the state is unable to effectively exercise jurisdiction for reasons not related to the required performance or structure of the plan shall be deemed to be an

issue not covered by the finally approved plan and shall be subject to federal enforcement. Where enforcement jurisdiction is shared between federal and state authorities, in the interest of administrative practicability, federal jurisdiction may be assumed. In either of the two above circumstances, federal enforcement may be exercised immediately upon agreement between the federal and state OSHA.

(c) Federal authority under provisions of the Act not listed in section 18(e) is unaffected by final approval of the plan. Thus, for example, the Assistant Secretary retains his authority under section 11(c) of the Act with regard to complaints alleging discrimination against employees who exercise any right afforded to them by the Act, although such complaints may be referred to the state for investigation. The Assistant Secretary also retains the authority to promulgate, modify, or revoke occupational safety and health standards which address the working conditions of all employees, including those in states which have received a final approval determination, although such standards may not be federally applied. In the event that the state's 18(e) status is subsequently withdrawn, and federal authority reinstated, all federal standards including any standards promulgated or modified during the 18(e) period would be federally enforceable in that state.

(d) OSHA will continue to monitor the operations of the Arizona state program to assure that the provisions of the state plan are substantially complied with and that the program remains at least as effective as the federal program. Failure by the state to comply with its obligations may result in the revocation of the final determination under section 18(e), resumption of federal enforcement and/or proceedings for withdrawal of plan approval.

Where the Plan May be Inspected

1952.356

A copy of the principal documents comprising the plan may be inspected and copied during normal business hours at the following locations: Office of State Programs, Occupational Safety and Health Administration, U.S. Dept. of Labor, 200 Constitution Avenue, NW., Room N3476, Washington D.C. 20210; Office of the Regional Administrator, Occupational Safety and Health Administration, U.S. Dept. of Labor, 11349 Federal Building, 450 Golden Gate Avenue, San Francisco CA 94102; and Office of the Arizona Division of Occupational Safety and Health, Industrial Commission of Arizona, 1624 W. Adams, Phoenix, AZ 85005.

CALIFORNIA

CALIFORNIA STATE PLAN OVERVIEW

The California state occupational safety and health plan was approved May 1, 1973, declared operational as of September 30, 1975, and certified as having completed all developmental steps as of August 19, 1977. The Department of Industrial Relations' Division of Occupational Safety and Health Administration (CAL/OSHA) enforces the plan.

California adopted several of the federal OSHA standards, including general industry (non-ionizing radiation, signs and tags, and bakery equipment), construction, and maritime. The plan also includes state-generated standards on construction, electrical safety, personal protection, cranes, radiation, noise, hazardous substances, fire protection, mine safety, and more. In 1976 the state enacted the Occupational Carcinogens Control Act, which regulates the use of carcinogens in the workplace, and in 1983 issued the Hazardous Substances Information and Training Act, an employee "right to know" law. The plan also requires permits for trench and excavation work, employer accident prevention programs, material safety data sheets, and can issue special orders to correct unsafe conditions.

The plan covers all employments in the state except those regulated by federal agencies other than OSHA and household domestic service.

Description of the Plan as Initially Approved

1952.170

(a) The state's program will be enforced by the Division of Industrial Safety of the Department of Industrial Relations of the California Agriculture and Services Agency. Current safety and health standards will be continued unless amended by a state occupational safety and health standards board to be created. This board will take the amending action necessary to assure that state standards are as effective as those established under the federal program. Appeals from the granting or denial of requests for variances will also come within the jurisdiction of this board. Administrative adjudications will be the responsibility of the California Occupational Safety and Health Appeals Board.

(b) The state program is expected to extend its protection to all employees in the state (including those employed by it and its political subdivisions) except those employed by federal agencies, certain maritime workers, household domestic service workers, and railroad workers not employed in railroad shops. (It is assumed that activities excluded from the Occupational Safety and Health Act's jurisdiction by section 4(b)(1)(29 U.S.C. 653(b)(1)) will also be excluded from the state's jurisdiction under this plan.)

(c) The plan includes procedures for providing prompt and effective standards for the protection of employees against new and unforeseen hazards and for furnishing information to employees on hazards, precautions, symptoms, and emergency treatment; and procedures for variances and the protection of employees from hazards. It provides employer and employee representatives an opportunity to accompany inspectors and call attention to possible violations before, during, and after inspections, protection or employees against discharge or discrimination in terms and conditions of employment, notice to employees or their representatives when no compliance action is taken upon complaints, including informal review, notice to employees of their protections and obligations, adequate safeguards to protect trade secrets, prompt notice to employers and employees of alleged violations of standards and abatement requirements, effective remedies against employers, and the right to review alleged violations, abatement periods, and proposed penalties with opportunity for employee participation in the review proceedings; procedures for prompt restraint or elimination of imminent danger conditions, and procedures for inspection in response to complaints.

(d) Based on an analysis of California's standards comparison, the state's standards corresponding to subparts F and K of this part, and 1910.263 of this (chapter) in subpart R of this part, of the OSHA standards have been determined to be at least as effective. These state standards contain no product standards. As indicated in 1952.173, the state's developmental schedule provides that the remaining

subparts will be covered by corresponding state standards which are at least as effective within one year of plan approval.

(e) The plan includes a statement of the governor's support for the proposed legislation and a statement of legal opinion that it will meet the requirements of the Occupational Safety and Health Act of 1970, and is consistent with the constitution and laws of California. The plan sets out goals and provides a timetable for bringing it into full conformity with part 1902 of this chapter upon enactment of the proposed legislation by the state legislature. A merit system of personnel administration will be used. In addition, efforts to achieve voluntary compliance by employers and employees will include both on and off-site consultations. The plan is supplemented by letters dated March 21, 1973, and April 10, 1973, from A.J. Reis, Assistant Secretary for Occupational Safety and Health of the Agriculture and Agency of the State of California.

Where The Plan May Be Inspected

1952.171

A copy of the plan may be inspected and copied during normal business hours at the following locations: U.S. Dept. of Labor, Office of Federal and State Operations, Occupational Safety and Health Administration, Room 800, 1726 M Street, N.W., Washington, D.C. 20210; Regional Office, Occupational Safety and Health Administration, Room 9470, Federal Office Building, 450 Golden Gate Avenue, San Francisco CA 94102; State of California, Agriculture and Services Agency, 1220 N Street, Room 114, Sacramento CA 95814; Department of Industrial Relations, 455 Golden Gate Avenue, Room 999, San Francisco CA 94102; and Division of Industrial Safety, 3460 Wilshire Boulevard, Room 916, Los Angeles CA 90010.

Level of Federal Enforcement

1952.172

Effective September 30, 1975, California is operational in the issues covered by the California occupational safety and health plan.

The. U.S. Department of Labor will continue to exercise authority, among other things, with regard to:

Complaints filed with the U.S. Department of Labor about violations of discrimination provisions of section 11(c) of the Act (29 U.S.C. 660(c));

Federal standards promulgated subsequent to the agreement where necessary to protect employees, as in the case of temporary emergency standards promulgated under section 6(c) of the Act (29 U.S.C.(c)), in the issues covered under the plan and the agreement until such time as California shall have adopted equivalent standards in accordance with Subpart C of 29 CFR Part 1953;

Federal standards contained in the issues covered by Subpart B, 29 CFR Part 1901, ship repairing, shipbuilding, shipbreaking, and longshoring, insofar as they relate to employment under the exclusive jurisdiction of the federal government on the navigable waters of the United States;

Enforcement activity regarding private employers on federal installations where the federal agency has claimed exclusive federal jurisdiction, challenged state jurisdiction and refused entry, such federal enforcement to continue at least until the jurisdictional question is resolved at the national level between the Occupational Safety and Health Administration and the cognizant federal agency;

Investigations and inspections for the purpose of evaluation of the California plan under sections 18(e) and (f) of the Act (29 U.S.C. 667(e) and (f)). The Assistant Regional Director for Occupational Safety and Health will make a prompt recommendation for resumption of the exercise of federal enforcement authority under section 18(e) of the Act (29 U.S.C. 667(e)) whenever, and to the degree necessary to assure occupational safety and health protection to employees in the state of California.

Developmental Schedule

1952.173

(a) Within one year following plan approval, legislation will be enacted authorizing complete implementation of the plan and enforcement rules and regulations will be promulgated, and an operations manual be completed.

(b) By October 31, 1975, present standards will be amended or new standards promulgated which are as effective and comprehensive as those set forth in Chapter XVII of Title 29 of the Code of Federal Regulations;

(c) An exception to paragraphs (a) and (b) of this section exists relative to radiation machines and other non-Atomic Energy Act sources of radiation. The standards and enforcement program in this area will be developed within 2 years of plan approval.

(d) Interagency agreements to provide technical support to the program will be fully functioning within 1 year of plan approval.

(e) Inservice training plans for enforcement personnel will be developed within 18 months of plan approval.

(f) A program of consultation with employers and employees will be functioning within six months of plan approval.

(g) Within three years of plan approval all developmental steps will be fully implemented.

(h) The inspection scheduling system will be fully implemented and in operation March 31, 1975.

Completion of Developmental Steps and Certification

1952.174

(a) (1) In accordance with 1952.173(a), the California Occupational Safety and Health Act (Assembly Bill No. 150) was enacted in September 1973 and filed with the California Secretary of State October 2, 1973.

(2) The following difference between the program described in 1952.170(a) and the program authorized by the state law is approved: authority to grant or deny temporary variances rests with the Division of Industrial Safety, and such authority for permanent variances is with the Occupational Safety and Health Standards Board. The board hears appeals from the Division of Industrial Safety's decisions on temporary variances.

(b) Formal interagency agreements were negotiated and signed between Department of Industrial Relations and the State Department of Health (June 28, 1973) and between the State Department of Industrial Relations and the State Fire Marshal (August 14, 1973).

(c) A program of consultation with employers and employees was fully functioning in January 1974.

(d) The California state poster was approved by the Assistant Secretary on August 27, 1975.

(e) The Occupational Safety and Health Standard Board began functioning in January 1974.

(f) The initial major training and education of employers, employees and the general public was completed by 1974.

(g) Recordkeeping and reporting requirements were extended to state and local governments effective January 1, 1975.

(h) The management information system was established by November 1974.

(i) The Occupational Safety and Health Appeals Board began functioning in early 1974 The Rules of Procedure for the Board were approved by the Assistant Secretary on November 19, 1975.

(j) Enforcement rules and regulations were promulgated by January 1974, and were approved by the Assistant Secretary on September 28, 1976.

(k) Recordkeeping and reporting requirements for private employers were promulgated by November 1974, and were approved by the Assistant Secretary on September 28, 1976.

(l) The inspection scheduling system was fully implemented and in operation by June 1975

(m) An operations manual was published, and was approved by the Assistant Secretary on September 28, 1976.

(n) In-service training programs for safety and health enforcement personnel were implemented within 18 months of plan approval.

(o) Enforcement of standards pertaining to temporary labor camps was implemented in March 1977.

(p) The California occupational safety and health plan was certified effective August 12, 1977 as having completed all developmental steps.

Changes to Approved Plans

1952.175

(a) The California carcinogen program implemented on January 1, 1977 was approved by the Assistant Secretary on March 7, 1978.

(b) On January 1, 1978, the California Department of Industrial Relations became the agency designated to administer the California occupational safety and health plan.

(c) California amended its employer recordkeeping and reporting requirements effective November 4, 1978, to provide employee access to the employer's log and summary of occupational injuries and illnesses.

(d) California's liaison with the Occupational Health Centers, implemented on April 25, 1979, was approved by the Assistant Secretary on July 25, 1980.

(e) The California Hazard Alert System implemented in July, 1979, was approved by the Assistant Secretary on July 25, 1980.

(f) The revised stratification of the Safety Engineer Series, adopted by California on July 1, 1979, was approved by the Assistant Secretary on January 12, 1981.

(g) California's Small Employer Voluntary Compliance Program, implemented on March 1, 1981, was approved by the Assistant Secretary on August 2, 1983.

CONNECTICUT

CONNECTICUT STATE PLAN OVERVIEW

After operating for 3½ years, the Connecticut state occupational safety and health plan covering private and public employees was revoked in 1977. A plan covering public employees only was approved October 2, 1978. The public employee plan covers state and local government employees only, and is enforced by the Connecticut Department of Labor's Occupational Safety and Health Division.

Special provisions of the plan include requiring foundries to provide employees with mandatory lung function tests and chest X-rays, a carcinogen and cancer policy, prohibiting discrimination based on pregnancy and childbearing capacity, and a toxics exposure law enacted in 1983.

Description of the Plan

1956.40

(a) The Connecticut Department of Labor is the state agency responsible for administering the plan throughout the state. Connecticut has adopted all federal standards as of September 1977 and has given assurances that it will adopt all federal standards, revisions, and amendments henceforth. Also, in those situations where public employees are exposed to unique hazards for which existing standards do not provide adequate protection, effective state standards will be adopted.

(b) The plan establishes procedures for variances and the protection of employees from hazards under a variance; insures inspection in response to complaints; provides employer and employee representatives an opportunity to accompany inspectors and call attention to violations before, during, and after inspections; notifies employees or their representatives when no compliance action is taken as a result of alleged violations, including informal review; notifies employees of their legal protection; protects employees against discharge or discrimination in terms and conditions of employment; provides for prompt notice to employers and employees of violations of standards and abatement requirements; provides for sanctions against employers for violation of standards and orders; assures employer's right to appeal citations for violations, abatement periods, and proposed penalties; ensures employee's right to appeal abatement periods, and employee participation in review proceedings. Also included are provisions for right of entry for inspection, "prohibition" of advance notice of inspection and the requirement for both employers and employees to comply with rules, standards, and orders, and employer obligations to maintain records and provide reports as required. Further, the plan provides assurances of a fully trained adequate staff and sufficient funding.

(c) The following documents are included in the plan:

(1) The plan document and appendices submitted January 30, 1978.

(2) Letter from the Commissioner, Connecticut Department of Labor, dated September 19, 1978, providing supplemental assurances.

Where the Plan May be Inspected

1956.41

A copy of the plan may be inspected and copied during normal business hours at the following locations: Office of State Programs, 2100 M Street NW, Room 149, Washington, D.C. 20210; Office of the Regional Administrator, Occupational Safety and Health Administration; Room 1804, John F. Kennedy Federal Building, Boston MA 02203; Connecticut Dept. of Labor, 200 Folly Brook Blvd., Wethersfield CT 06109.

Developmental Schedule

1956.43

The Connecticut plan is developmental. The following is a schedule of major developmental steps as provided by the plan:

(a) A new state poster will be printed by December 15, 1978, in order to reflect coverage of the public sector only.

(b) Standards identical to or at least as effective as all existing federal standards will be adopted by February 1, 1979.

(c) Connecticut regulations equivalent to the following federal provisions will be revised by April 1, 1979 to show coverage of the public sector only and to accurately reflect the current program: 29 CFR Part 1903 (Inspections, Citations, and Proposed Penalties); 29 CFR Part 1904 (Recording and Reporting of Occupational Injuries and Illnesses); 29 CFR Part 1905 (Variance Rules); 29 CFR Part 2200 (Review Commission); and the Field Operations Manual.

(d) The state will submit revised and updated provisions dealing with employee discrimination by May 1, 1979.

(e) The state will prepare by June 1, 1979 a comprehensive list of government entities whose employees are covered by the plan, giving the number of employees for each entity, describing the work performed, and assigning for each entity a standard industrial classification (SIC) code.

(f) The state will resubmit its plan in the required outline format by October 1, 1979.

Completed Developmental Steps

1956.44

(a) Connecticut's reformatted and revised plan and narrative description were approved by the Assistant Secretary on August 3, 1983.

(b) Connecticut's safety and health poster for public employees was approved by the Assistant Secretary on August 3, 1983.

(c) Connecticut has promulgated standards identical to all basic federal standards in 29 CFR Parts 1910, 1926, and 1928. The state has continued to adopt federal standards, amendments, and corrections as noted in separate standards approval notices.

(d) Connecticut promulgated rules for inspections, citations, and proposed penalties; recordkeeping and reporting occupational injuries and illness; rules of practice for variances; and review commission procedures. In addition, Connecticut adopted field operations and industrial hygiene manuals identical to the federal versions. These supplements were approved by the Assistant Secretary on August 3, 1983.

(e) Connecticut's employee discrimination provisions were approved by the Assistant Secretary on August 3, 1983.

(f) Connecticut's comprehensive list classifying governmental entities covered by the plan was approved by the Assistant Secretary on August 3, 1983.

HAWAII

HAWAII STATE PLAN OVERVIEW

The Hawaii occupational safety and health plan was approved January 4, 1974, declared operational May 19, 1976, and certified on May 9, 1978. After determining the plan at least as effective as federal standards, the Hawaii plan was granted final approval effective April 30, 1984.

The Hawaii plan covers all occupational activities except maritime industries, household domestic service, federal employees, and employees whose safety is regulated by federal agencies other than OSHA. The Department of Labor and Industrial Relations is responsible for enforcing the plan.

Although the state did not adopt federal OSHA standards, an estimated 90% of its standards are identical to the federal standards. Special provisions include requiring general contractors having 30 or more employees at construction or demolition projects to make daily inspections, and requiring all employers to develop an occupational safety and health program tailored to the workplace.

Description of the Plan as Initially Approved:

1952.310

(a) The plan designates the Department of Labor and Industrial Relations as the agency responsible for administering the plan throughout the state. It proposes to define the occupational safety and health issues covered by it as defined by the Secretary of Labor in 29 CFR 1902.2(c)(1). All occupational safety and health standards promulgated by the U.S. Secretary of Labor will be adopted under the plan as well as certain standards deemed to be "as effective as" the federal standards, except those found in 29 CFR Parts 1915, 1917, and 1918 (ship repairing, shipbuilding, shipbreaking and longshoring).

(b) Within the plan there is the Hawaii Occupational Safety and Health Law which became law on May 16, 1972. The law enacted gives the Department of Labor and Industrial Relations the authority to inspect workplaces and to issue citations for the abatement of violations and there is also included a prohibition against advance notice of such inspections. The law is also intended to insure employer and employee representatives an opportunity to accompany inspectors and to call attention to possible violations; notification of employees or their representatives when no compliance action is taken as a result of alleged violations; protection of employees against discharge or discrimination in terms and conditions of employment; and adequate safeguards to protect trade secrets. There is provision made for the prompt restraint of imminent danger situations and a system of penalties for violation of the law.

(c) The plan also includes proposed amendments to be considered by the Hawaii legislature during its 1974 session amending the Occupational Safety and Health Law, and related provisions, to bring them into conformity with the requirements of Part 1902.

(d) The Hawaii plan includes the following documents as of the date of approval:

(1) The plan description documents, including the Hawaii Occupational Safety and Health Law, the proposed amendments to the law and appendices in three (3) volumes;

(2) Letter from Robert K. Hasegawa, Director of the Department of Labor and Industrial Relations, to Jay Arnoldus, Project Officer, Office of Federal and State Operations, December 10, 1973, submitting clarifications to the plan.

(3) Letters from Robert C. Gilkey, Deputy Director of the Department of Labor and Industrial Relations, to Jay Arnoldus, December 3, 1973 and December 4, 1973 submitting clarifications to the plan.

(4) Letters from Robert K. Hasegawa to Gabriel Gillotti, Assistant Regional Director, January 30, 1973, and June 28, 1973.

(5) Letter from Robert A. Gilkey to John H. Stender, Assistant Secretary of Labor, October 30, 1973.

(6) Letters from Robert K. Hasegawa to John H. Stender, Assistant Secretary of Labor, November 7, 1973 and September 14, 1973 submitting proposed legislative amendments and modifications and clarifications to the plan.

Developmental Schedule

1952.311

(a) Introduction of legislative amendments to state legislature, January 1974.

(b) Hearing on standards promulgation, March 1974.

(c) Implementation of management information system, 1974.

(d) Complete implementation of occupational health program, December 1974.

(e) Complete state plan implementation, December 1976.

Completion of Developmental Steps and Certification

1952.312

(a) Specific legislative amendments were enacted by the state legislature and signed by the acting governor on June 7, 1974.

(b) The Hawaii Occupational Health Plan was submitted to the Assistant Secretary on April 16, 1974 and approved on December 20, 1974, incorporating assurances from the state, by letter dated November 19, 1974.

(c) The Hawaii occupational safety and health standards were promulgated on April 18, 22, 23, 24, and 25, 1975.

(d) The Hawaii state poster was approved by the Assistant Secretary on February 4, 1975.

(e) The Hawaii occupational health program was implemented on July 1, 1975.

(f) The rules of procedure include requirements for: inspections, citations, and proposed penalties; recording and reporting occupational injuries and illnesses; rules of practice for variances; regulations concerning administration witnesses and documents in private litigation; and regulations for promulgating, modifying, or revoking occupational safety and health standards.

(g) The Hawaii management information system was completed and in operation by December 31, 1975.

(h) The Hawaii occupational safety and health plan was certified effective April 26, 1978 as having completed all developmental steps.

Final Approval Determination

1952.313

(a) In accordance with section 18(e) of the Act and procedures in 29 CFR Part 1902, and after a determination that the state met the "fully effective" compliance staffing benchmarks as established in 1980 in response to a court order, and was satisfactorily providing reports to OSHA through participation in the federal-state unified management information system, the Assistant Secretary evaluated actual operations under the Hawaii state plan for at least one year following certification of completion of developmental steps. Based on the evaluation report for FY 1982 and available FY 1983 data, and after opportunity for public comment and an informal public hearing, the Assistant Secretary determined that in actual operations, the state of Hawaii occupational safety and health program is at least as effective as the federal program in providing safe and healthful employment and places of employment and meets the criteria for final state plan approval. Accordingly, the Hawaii plan was granted final approval and concurrent federal enforcement authority was relinquished effective April 30, 1984.

(b) The plan covers all employers and all places of employment in Hawaii except for private sector maritime employment.

(c) Hawaii is required to maintain a state program which is at least as effective as the federal program, to submit plan supplements in accordance with 29 CFR Part 1953, to allocate sufficient safety and health enforcement staff to meet the benchmarks for state staffing established by the U.S. Department of Labor, or any revisions to those benchmarks, and to furnish such reports in such form as the Assistant Secretary may from time to time require.

Level of Federal Enforcement

1952.314

(a) As a result of the final approval determination, standards under section 7 of the Act do not apply to issues covered under the Hawaii plan. This determination also relinquishes federal OSHA authority to issue citations for violations of standards under sections 5(a)(2) and 9 of the Act; to conduct inspections and investigations under section 8 [except those necessary to evalute the plan under section 18 or other inspections, investigations, or proceedings necessary to carry out federal responsibilities not pre-empted by section 18(e)]; to conduct enforcement proceedings in contested cases under section 10; to institute proceedings to correct imminent dangers under section 13; and to propose civil penalties or initiate criminal proceedings for violations of the federal Act under section 17. The Assistant Secretary may retain jurisdiction over any proceeding commenced under section 9 or 10 before April 30, 1984.

(b) Federal authority under provisions of the Act not listed in section 18(e) is not affected by final approval of the plan. Thus, for example, the Assistant Secretary retains his authority under section 11(c) of the Act with regard to complaints alleging discrimination against employees who exercise any right afforded to them by the Act, although such complaints may be referred to the state for investigation. The Assistant Secretary also retains the authority to promulgate, modify, or revoke occupational safety and health standards which address the working conditions of all employees, including those in states which have received a final approval determination, although such standards may not be federally applied. In the event that the state's 18(e) status is subsequently withdrawn, and federal authority reinstated, all federal standards including any standards promulgated or modified during the 18(e) period would be federally enforceable in that state.

(c) OSHA will continue to monitor the operations of the Hawaii state program to assure that the provisions of the state plan are substantially complied with and that the program remains at least as effective as the federal program. Failure by the state to comply with its obligations may result in the revocation of the final determination under section 18(e), resumption of federal enforcement and/or proceedings for withdrawal of plan approval.

Where the Plan May be Inspected

1952.315

A copy of the principal documents comprising the plan may be inspected and copied during normal business hours at the following locations: Office of State Programs, Occupational Safety and Health Administration, U.S. Dept. of Labor, 200 Constitution Avenue, NW., Room N3700, Washington D.C. 20210; Regional Administrator, Occupational Safety and Health Administration, U.S. Dept. of Labor, 11349 Federal Building, 450 Golden Gate Avenue, San Francisco CA 94102; and Office of the Administrator, Hawaii Dept. of Labor and Industrial Relations, Division of Occupational Safety and Health, 677 Ala Moana, Suite 910, Honolulu HI 96913.

INDIANA

INDIANA STATE PLAN OVERVIEW

The Indiana state occupational safety and health plan was approved March 6, 1974, declared operational on August 6, 1974, and granted certification on October 16, 1981. On May 16, 1986, the Indiana plan was declared eligible for final approval. The plan is enforced by the Indiana Department of Labor (IOSHA), and the standards are essentially identical to the federal OSHA standards

The plan applies to all Indiana employees, public and private, except for federal employees and those employees whose safety is regulated by another federal agency (such as the Nuclear Regulatory Commission).

Description of the Plan as Initially Approved:

1952.320

(a) (1) The plan identifies the Indiana Division of Labor as the state agency designated to implement and carry out the state plan. Within this structure, the Occupational Safety Standards Commission has the responsibility to adopt standards and dispose of variance applications; the Commissioner of Labor is charged with the administration and enforcement of the Act; and the Board of Safety Review is to conduct and decide contested cases. The State Board of Health, Industrial Hygiene Division, pursuant to an agreement with the Division of Labor will provide laboratory sevices and will conduct occupational health inspections as scheduled by the Division of Labor.

(2) The plan defines the covered occupational safety and health issues as defined by the Secretary of Labor in 29 CFR 1902.2(c)(1). Further, Indiana has adopted all federal safety and health standards contained in 29 CFR Parts 1910 and 1926. The state program is to extend its protection to all employees in the state including those employed by it and its political subdivisions.

(b) The plan includes existing enabling legislation and the Indiana Occupational Safety and Health Act as well as amendments to this Act which were passed and became effective May 1, 1973. Under the Act as amended the Division of Labor has authority to administer and enforce the provisions of the state plan.

(c) The legislation provides procedures for the promulgation of standards; furnishing information to employees on hazardous and toxic substances; and procedures for granting temporary and permanent variances. The law also contains procedures for inspections including inspections in response to complaints; ensures employer and employee representatives an opportunity to accompany inspectors and to call attention to possible violations before, during and after inspections; protection of employees against discharge or discrimination in terms or conditions of employment through court suits brought by the attorney general at the request of the commissioner; notice to employees of their protections and obligations under the state law; prompt restraint of imminent danger situations; safeguard to protect trade secrets; prompt notice to employers and employees of alleged violations of standards and abatement requirements; effective sanctions against employers; and employer right to review alleged violations, abatement periods, and proposed penalties with an opportunity for employee participation and employee right to review abatement periods.

(d) The plan also contains a voluntary compliance program. The state will conduct seminars, conferences and meetings designed for management, supervisory personnel, employees and union representatives to transmit information about its safety and health program. These programs are specifically designed to cover the following areas: general industrial safety, construction safety, first aid instruction, supervisory safety training, hazard recognition, Indiana occupational health and safety laws, federal occupational safety and health laws, state health and safety standards, injury and illness reporting procedures requirements, rights and obligations to employers and employees, enforcement programs. On-site consultation services will be available for employers upon request as part of the developmental plan.

(e) Also included in the plan are proposed budgets to be devoted to it as well as descriptions of the job classifications and personnel who will be carrying out the program. Further, the plan sets out goals and provides a timetable for bringing it into full conformity with 29 CFR Part 1902.

Developmental Schedule

1952.321

(a) Proposed legislative amendments to be introduced in the 1974 session of the state legislature;

(b) Refresher course for inspectors will be completed by September 1, 1974;

(c) A full complement of 69 inspectors will be hired by the end of the first year of plan operation; the state will add 10 inspectors for each of the two succeeding years;

(d) Development of a state employee safety program within nine months following plan approval;

(e) Establishment of the rules of procedure of onsite consultations within nine months following plan approval;

(f) Within three years of plan approval all developmental steps will be fully implemented.

Completed Developmental Steps

1952.322

(a) The Indiana poster was approved for use until federal enforcement authority and standards become inapplicable to issues under the plan, by the Assistant Secretary on March 2, 1976.

(b) Indiana amended the Indiana Occupational Safety and Health Act in 1975, 1977, and 1978. These amendments were approved by the Assistant Secretary on September 24, 1981.

(c) Indiana submitted documentation outlining training and refresher courses for its compliance staff on May 19, 1975 and May 4, 1981. This supplement was approved by the Assistant Secretary on September 24, 1981.

(d) Indiana submitted documentation on May 4, 1981 showing that it had substantially met its compliance staffing commitments by providing 14 health and 70 safety compliance officers. This supplement was approved by the Assistant Secretary on September 24, 1981.

(e) Indiana developed an occupational safety and health program for public employees on August 25, 1975 and resubmitted a revised program with implementing regulations on September 5, 1981. These were approved by the Assistant Secretary on September 24, 1981.

(f) Indiana promulgated rules for onsite consultation on March 7, 1975 which were amended on September 5, 1981. These regulations were approved by the Assistant Secretary on September 24, 1981.

(g) Indiana submitted its compliance operations manual on August 7, 1975 which was subsequently revised in 1978 and again on June 4, 1980. A revised industrial hygiene manual was submitted July 15, 1981. These manuals, which reflect changes in the federal program through 1980 were approved by the Assistant Secretary on September 24, 1981.

(h) Indiana promulgated regulations for inspections, safety orders, and proposed penalties on January 18, 1977 with amendments dated July 29, 1977 and September 5, 1981. These regulations were approved by the Assistant Secretary on September 24, 1981.

(i) Indiana promulgated regulations for recordkeeping and reporting of occupational injuries and illnesses on January 18, 1977 which were amended on September 10, 1979. The state also revised its recordkeeping and reporting provisions for the public sector on September 5, 1981. These regulations were approved by the Assistant Secretary on September 24, 1981.

(j) Indiana promulgated rules for variances, limitations, variations, tolerances, and exemptions on December 17, 1976 which were revised June 3, 1977 and September 5 1981. These regulations were approved by the Assistant Secretary on September 24, 1981.

(k) Indiana adopted rules of procedure for the Board of Safety Review on September 19, 1976, which were subsequently amended on September 5, 1981. These regulations were approved by the Assistant Secretary on September 23, 1981.

(l) Indiana deleted coverage of the maritime and longshoring issues from its plan on June 9, 1981. This supplement was approved by the Assistant Secretary on September 24, 1981.

(m) Indiana submitted documentation on establishment of its management information system on May 20. This supplement was approved by the Assistant Secretary on September 24, 1981.

(n) The Indiana occupational safety and health plan was certified, effective October 16, 1981, as having completed all developmental steps specified in the plan. This certification attests to structural completion, but does not render judgement on adequacy of performance.

Compliance Staffing Benchmarks

1952.323

Compliance staffing levels necessary for a "fully effective" enforcement progam needed to be established for each state operating an approved state plan. In September 1984, Indiana, in conjunction with OSHA, completed a reassessment of the levels initially established in 1980 and proposed revised compliance staffing benchmarks of 47 safety and 23 health compliance officers. After opportunity for public comment and service on the AFL-CIO, the Assistant Secretary approved these revised staffing requirements on January 17, 1986.

Final Approval Determination

1952.324

(a) After determining that Indiana met the "fully effective" compliance staffing benchmarks as revised in 1984 and that the state was providing reports to OSHA through participation in the federal-state unified management information system, the Assistant Secretary evaluated operations under the Indiana state plan for at least one year following certification. Based on the evaluation report and after opportunity for public comment, the Assistant Secretary determined that the Indiana state occupational safety and health plan was at least as effective as the federal program in providing safe and healthful employment and places of employment and meets the criteria for final state plan approval. Accordingly, the Indiana state plan was granted final approval and concurrent federal enforcement authority was relinquished effective September 26, 1986.

(b) The plan covers all activities of employers and all places of employment in Indiana except for private sector maritime employment and private sector hazardous waste disposal facilities designated as Superfund sites.

(c) Indiana is required to maintain a state program which is at least as effective as the federal program; to submit plan supplements; to allocate sufficient safety and health enforcement staff to meet benchmarks for state staffing established by the U.S. Department of Labor, or any revision to March 1987 OSHA Supplement — Indiana State Plan Update 2 those benchmarks; and to furnish such reports in such form as the Assistant Secretary may from time to time require.

Level of Federal Enforcement

1952.325

(a) As a result of the granting of final approval to the Indiana plan effective September 26, 1986, occupational safety and health standards which have been promulgated under section 6 of the Act do not apply with respect to issues covered under the Indiana plan. This determination also relinquishes concurrent federal OSHA authority to issue citations for violation of such standards under section 5(a)(2) and 9 of the Act; to conduct inspections and investigations under section 8 [except those necessary to conduct evaluation of the plan under section 18(f) and other inspections, investigations, or proceedings necessary to carry out federal responsibilities not preempted by section 18(e)], to conduct

enforcement proceedings in contested cases under section 10; to institute proceedings to correct imminent dangers under section 13; and to propose civil penalties or initiate criminal proceedings for violations of the federal act under section 17. The Assistant Secretary retains jurisdiction under the above provision in any proceeding commenced under section 9 or 10 before September 26, 1986.

(b) Final approval relinquishes federal OSHA authority only with regard to occupational safety and health issues covered by the Indiana plan. OSHA retains full authority over issues which are not subject to state enforcement. Thus federal OSHA retains its authority relative to safety and March 1987 OSHA Supplement — Indiana State Plan Update 3 health in private sector maritime activities and will continue to enforce all provisions of the Act, rules or orders, and all federal standards, current or future, specifically directed to private sector maritime employment (29 CFR Part 1915, shipyard employment; Part 17, marine terminals; Part 1918, longshoring; and Part 1919, gear certification) as well as provisions of general industry standards appropriate to hazards found in these employments. Federal jurisdiction is also retained at private sector hazardous waste disposal facilities designated as Superfund sites, and with respect to federal government employers and employees. In addition, any hazard, industry, geographical area, operation or facility over which the state is unable to effectively exercise jurisdiction for reasons not related to the required performance or structure of the plan shall be deemed to be an issue not covered by the finally approved plan and shall be subject to federal enforcement. Where enforcement jurisdiction is shared between federal and state authorities, in the interest of administrative practicability, federal jurisdiction may be assumed. In either of the two above circumstances, federal enforcement may be exercised immediately upon agreement between the federal and state OSHA.

(c) Federal authority under provisions of the Act not listed in section 18(e) is unaffected by final approval of the plan. Thus, for example, the Assistant Secretary retains his authority under section 11(c) of the Act with regard to complaints alleging discrimination against employees who exercise any right afforded to them by the Act, although such complaints may be referred to the state for investigation. The Assistant Secretary also retains the authority to promulgate, modify, or revoke occupational March 1987 OSHA Supplement — Indiana State Plan Update 4 safety and health standards which address the working conditions of all employees, including those in states which have received a final approval determination, although such standards may not be federally applied. In the event that the state's 18(e) status is subsequently withdrawn, and federal authority reinstated, all federal standards including any standards promulgated or modified during the 18(e) period would be federally enforceable in that state.

(d) OSHA will continue to monitor the operations of the Indiana state program to assure that the provisions of the state plan are substantially complied with and that the program remains at least as effective as the federal program. Failure by the state to comply with its obligations may result in the revocation of the final determination under section 18(e), resumption of federal enforcement and/or proceedings for withdrawal of plan approval.

IOWA

IOWA STATE PLAN OVERVIEW

The Iowa state occupational safety and health plan received approval July 20, 1973, was declared operational July 1, 1975, and certified as of September 4, 1976. After a determination that the plan was at least as effective as federal OSHA standards, OSHA granted the Iowa state plan final approval July 2, 1985. The plan is enforced by the Iowa Bureau of Labor.

The Iowa state plan contains essentially the same requirements as the federal OSHA standards, and covers all employments in the state except the maritime industries, federally controlled worksites, "Superfund" sites, bridge construction between Iowa and other states across the Mississippi or Missouri rivers, and worksites covered by other federal agencies such as the Nuclear Regulatory Commission.

Iowa also has extended the requirements of the federal hazard communication standard to all employees except those covered by FIFRA (agricultural activities) and those involved with transporting of hazardous chemicals who are covered by other federal regulations.

Description of Plan as Initially Approved

1952.160

(a) (1) The plan identifies the Bureau of Labor as the state agency designated to administer the plan throughout the state. Its responsibilities include both occupational safety and occupational health, the latter on a developmental basis. The plan defines the covered occupational safety and health issues as defined by the Secretary of Labor in 29 CFR 1902.2(c)(i). Under existing occupational safety and health legislation, effective July 1, 1972, Iowa has adopted as interim standards all the occupational safety and health standards and amendments thereto which had been promulgated by the Secretary of Labor, except those found in 29 CFR Parts 1915, 1916, 1917 and 1918 (ship repairing, shipbuilding, shipbreaking and longshoring). Hearings have been held on adoption, as permanent standards, of the standards in 29 CFR Parts 1910 and 1926.

Under its existing legislation, the Bureau of Labor has exercised statewide inspection authority to enforce state standards which are identical to federal standards. The legislation covers all employers including the state and its political subdivisions and gives the Iowa Bureau of Labor full authority to administer and enforce all laws, rules, and orders protecting employee safety and health in all places of employment in the state.

(2) The legislation contains procedures for the promulgation of standards, including standards for the prompt protection of employees against new and unforeseen hazards; furnishing information to employees on hazards, precautions, symptoms, and emergency treatment; procedures for granting temporary and permanent variances; and for the protection of employees from hazards. The law provides for inspections including inspections in response to complaints; ensures employer and employee representatives an opportunity to accompany inspectors and call attention to possible violations before, during and after inspections; protection of employees against discharge or discrimination in terms or conditions of employment through court suits brought by the Bureau of Labor; notice to employees of their protections and obligations under the state law; imminent danger abatement through court jurisdictions injunctions; safeguards to protect trade secrets; prompt notice to employers and employees of alleged violations of standards and abatement requirements; effective sanctions against employers; employer right to review of alleged violations, abatement periods, and proposed penalties with an opportunity for employee review of any citation issued to the employee, in review proceedings before the independent Review Commission.

(3) The plan is developmental in the establishment of a compliance program for agriculture, mercantile and service employees; development of an occuptional health program; developing a management information system; and hiring and training of staff under the existing merit system.

(b) Included in the plan is a statement of the governor's support for the plan and a statement of legal opinion that the legislation will meet the requirements of the Occupational Safety and Health Act of 1970 and is consistent with the constitution and laws of Iowa. The plan sets out goals and provides a timetable for bringing it into full conformity with Part 1902 at the end of three years after the commencement of operations under the plan.

(c) Chapter 5 of the Iowa Bureau of Labor Administrative Rules dealing with rules of practice for variances, limitations, variations, tolerances, and exemptions adopted July 25, 1972, and amended October 5, 1972.

These adopted rules and regulations which were not part of the plan as originially submitted will be evaluated in accordance with the review of completions of developmental steps in state plans.

Developmental Schedule

1952.161

The Iowa state plan is developmental. The following is the developmental schedule as amended and provided by the plan:

(a) Legislation becomes effective (SF 1218 — Chapter 88 Iowa Code), July 1972.

(b) Corrective amendments to Chapter 88 become effective, July 1975.

(c) Adoption of federal standards as temporary state standards, July 1972.

(d) Adoption of federal standards as permanent state standards, July 1973.

(e) Update of state standards to remain identical with federal standards in issues covered, (ongoing).

(f) Complete hiring of additional staff, April 1975.

(g) Complete basic training of all staff, May 1975.

(h) Advanced training of all staff (ongoing).

(i) Commencement of compliance activities, July 1972.

(j) Development of compliance programs in agricultural, mercantile, and services issues, August 1975.

(k) Development of onsite consultative inspection program, September 1975.

(l) Development of approved state poster, August 1975.

(m) Development of a program of education and training of employers and employees, October 1974.

(n) Development of a manual management information system, July 1972.

(o) Development of an automated management information system, (ongoing).

(p) Modification of state compliance manual, November 1975.

Completion of Developmental Steps and Certification

1952.162

(a) The Iowa state poster was approved by the Assistant Secretary on August 26, 1975.

(b) The Iowa Occupational Safety and Health Act of 1972 (Iowa S.F. 1218 — Chapter 88) is amended by Iowa Act S.F. 92, with an effective date of July 1, 1975.

(c) The state of Iowa enacted occupational safety and health enabling legislation which became effective on July 1, 1972.

(d) The state of Iowa, as of April 24, 1974, hired a sufficient number of qualified safety and health personnel under the approved Iowa Merit Employment Department system.

(e) All basic training of Iowa compliance personnel was completed as of May 9, 1975.

(f) A program of education and training of employers and employees was developed with local community colleges as of October 1974.

(g) The Iowa Bureau of Labor developed an approved manual management information system as of July 1972.

(h) The Iowa Bureau of Labor initiated an approved program of onsite consultation as of September 1975.

(i) The state of Iowa adopted federal standards as interim state standards under Chapter 88 of the Iowa Code, effective on July 1, 1972.

(j) The state of Iowa promulgated federal occupational safety and health standards (29 CFR Parts 1910 and 1926) as permanent state standards as of August 16, 1973.

(k) The Iowa Bureau of Labor began its compliance activities in July 1973.

(l) The Iowa Bureau of Labor implemented compliance programs in the agriculture, mercantile, and service issues by July 1975.

(m) The Iowa safety and health plan program was certified on September 14, 1976 as having completed all developmental steps in its plan with regard to those occupational safety and health issues specified in the plan on or before July 20, 1976.

(n) Amendment to Chapter 4, Recording and Reporting occupational Injuries and Illnesses: clarifications of the Iowa recordkeeping and reporting rules.

(o) Amendment to Chapter 6, IOSH Consultative Services and Training: detailed procedures for safety consultants when they find a serious or imminent danger hazard.

(p) Modifications to the Iowa plan: minor revisions to the Iowa plan dealing with present staffing, position statements, legislative changes, and current responsibilities of divisions in the Iowa Bureau of Labor.

Compliance Staffing Benchmarks

1952.163

Compliance staffing levels (benchmarks) necessary for a "fully effective" enforcement program needed to be established for each state operating an approved state plan. In September, 1984, Iowa in conjunction with OSHA completed a reassessment of the levels initially established in 1980 and proposed revised compliance staffing benchmarks of 16 safety and 13 health compliance officers. These revised staffing requirements were approved by the Assistant Secretary effective July 2, 1985.

Final Approval Determination

1952.164

(a) After determining that Iowa met the "fully effective" compliance staffing benchmarks as revised in 1984 and that the state was providing reports to OSHA through participation in the federal—state unified management information system, the Assistant Secretary evaluated operations under the Iowa state plan for at least one year following certification. Based on the evaluation report and after opportunity for public comment, the Assistant Secretary determined that the Iowa state occupational safety and health plan was at least as effective as the federal program in providing safe and healthful employment and places of employment and meets the criteria for final state plan approval. Accordingly, the Iowa state plan was granted final approval and concurrent federal enforcement authority was relinquished effective July 2, 1985.

(b) The plan covers all activities of employers and all places of employment in Iowa except for private sector maritime; federal government owned, contractor operated military/munitions facilities; bridge construction projects spanning the Mississippi and Missouri rivers between Iowa and other states; and private sector hazardous waste disposal facilities designated as "Superfund sites."

(c) Iowa is required to maintain a state program which is at least as effective as the federal program; to submit plan supplements; to allocate sufficient safety and health enforcement staff to meet benchmarks for state staffing established by the U.S. Department of Labor, or any revision to those benchmarks; and to furnish such reports in such form as the Assistant Secretary may from time to time require.

Level of Federal Enforcement

1952.165

(a) As a result of the granting of final approval to the Iowa plan effective July 2, 1985, occupational safety and health standards which have been promulgated under section 6 of the Act do not apply with respect to issues covered under the Iowa plan. This determination also relinquishes concurrent federal OSHA authority to issue citations for violation of such standards under section 5(a)(2) and 9 of the Act; to conduct inspections and investigations under section 8 [except those necessary to conduct evaluation of the plan under section 18(f) and other inspections, investigations, or proceedings necessary to carry out federal responsibilities not preempted by section 18(e)]; to conduct enforcement proceedings in contested cases under section 10; to institute proceedings to correct imminent dangers under section 13; and to propose civil penalties or initiate criminal proceedings for violations of the federal act under section 17. The Assistant Secretary retains jurisdiction under the above provision in any proceeding commenced under section 9 or 10 before July 2, 1985.

(b) Final approval relinquishes federal OSHA authority only with regard to occupational safety and health issues covered by the Iowa plan. OSHA retains full authority over issues which are not subject to state enforcement. Thus federal OSHA retains its authority relative to safety and health in private sector maritime activities and will continue to enforce all provisions of the Act, rules or orders, and all federal standards, current or future, specifically directed to private sector maritime employment (29 CFR Part 1915, shipyard employment; Part 17, marine terminals; Part 1918, longshoring; and Part 1919, gear certification) as well as provisions of general industry standards appropriate to hazards found in these employments; federal government-owned, contractor-operated military/munitions facilities; bridge construction projects spanning the Mississippi and Missouri rivers between Iowa and other states; and private sector hazardous waste disposal facilities designated as "Superfund sites." In addition, any hazard, industry, geographical area, operation or facility over which the state is unable to effectively exercise jurisdiction for reasons not related to the required performance or structure of the plan shall be deemed to be an issue not covered by the finally approved plan and shall be subject to federal enforcement. Where enforcement jurisdiction is shared between federal and state authorities, in the interest of administrative practicability, federal jurisdiction may be assumed. In either of the two above circumstances, federal enforcement may be exercised immediately -upon agreement between the federal and state OSHA.

(c) Federal authority under provisions of the Act not listed in section 18(e) is unaffected by final approval of the plan. Thus, for example, the Assistant Secretary retains his authority under section 11(c) of the Act with regard to complaints alleging discrimination against employees who exercise any right afforded to them by the Act, although such complaints may be referred to the state for investigation. The Assistant Secretary also retains the authority to promulgate, modify, or revoke occupational safety and health standards which address the working conditions of all employees, including those in states which have received a final approval determination, although such standards may not be federally applied. In the event that the state's 18(e) status is subsequently withdrawn, and federal authority reinstated, all federal standards including any standards promulgated or modified during the 18(e) period would be federally enforceable in that state.

(d) OSHA will continue to monitor the operations of the Iowa state program to assure that the provisions of the state plan are substantially complied with and that the program remains at least as effective as the federal program. Failure by the state to comply with its obligations may result in the revocation of the final determination under section 18(e), resumption of federal enforcement and/or proceedings for withdrawal of plan approval.

Where the Plan May be Inspected

1952.166

A copy of the principal documents comprising the plan may be inspected and copied during normal business hours at the following locations: Office of State Programs, Occupational Safety and Health Administration, U.S. Dept. of Labor, 200 Constitution Avenue, NW., Room N3476, Washington D.C. 20210; Office of the Regional Administrator, Occupational Safety and Health Administration, U.S. Dept. of Labor, 911 Walnut Street, Room 406, Kansas City, MO 64106; and Office of the Commissioner, Iowa Bureau of Labor, State House, 307 East 7th St., Des Moines IA 50319.

KENTUCKY

KENTUCKY STATE PLAN OVERVIEW

The Kentucky state occupational safety and health plan received initial approval from OSHA July 31, 1973, was declared operational November 18, 1974 and was certified effective February 8, 1980. After a determination that the plan was at least as effective as the federal OSHA standards, OSHA granted the Kentucky state occupational safety and health plan final approval on June 13, 1985. The plan is enforced by the Kentucky Labor Cabinet.

The plan applies to all employments in the state except maritime industries, Tennessee Valley Authority facilities, military bases, and U.S. government employers and employees Kentucky adopted state standards identical to OSHA's general industry, construction, and agriculture standards, but has modified some and added standards covering hazards not covered by the federal OSHA, including standards for confined spaces work, firefighters' clothing and equipment, and refuse collection and compaction equipment.

Description of the Plan as Initially Approved

1952.230

(a) The plan designates the Department of Labor as the agency responsible for administering the plan throughout the state. All occupational safety and health standards promulgated by the United States Secretary of Labor have been adopted under the plan as well as a certain standard deemed to be "as effective as" the federal standard, except those found in Parts 1915, 1916, 1917, and 1918 of this chapter (ship repairing, shipbuilding, shipbreaking and longshoring). All federal standards adopted by the state became effective on December 29, 1972.

(b) Within the plan there is enabling legislation revising Chapter 338 of the Kentucky Revised Statutes which became law on March 27, 1972; as well as legislation enacted and approved in a special session of the legislature in 1972 amending the enabling legislation. The law as enacted and modified gives the Department of Labor, Division of Occupational Safety and Health, the statutory authority to implement an occupational safety and health plan modeled after the federal act. There are provisions within it granting the commissioner of labor the authority to inspect the workplaces and to issue citations for the abatement of violations and there is also included a prohibition against advance notice of such inspections. The law is also intended to insure employer and employee representatives an opportunity to accompany inspectors and to call attention to possible violations; notification of employees or their representatives when no compliance action is taken as a result of employee alleged violations; protection of employees against discrimination in terms and conditions of employment; and adequate safeguards to protect trade secrets. There is provision made for the prompt restraint of imminent danger situations and a system of penalties for violation of the statute. There are also provisions creating the Kentucky Occupational Safety and Health Standards Board and the Kentucky Occupational Safety and Health Review Board. The law has further provision that the Department of Labor will enter into an agreement with the Public Service Commission (PSC) which shall serve as the state agency in the administration of all matters relating to occupational safety and health with respect to employees of public utilities.

(c) The plan includes an opinion from the attorney that the law is consistent with the constitution of the state. There is also set forth in the plan a time for the development of a public employee program. The plan also contains a comprehensive description of personnel employed under the state's merit system as well as its proposed budget and resources.

Developmental Schedule

1952.231

The Kentucky state plan is developmental. The following is the developmental schedule as provided by the plan:

(a) A comprehensive public employee program will be developed within three years of plan approval.

(b) Within six months after plan approval, the procedure for the promulgation of standards will be revised.

(c) An affirmative action program will be submitted to the Assistant Secretary as well as clearance of possible inconsistencies of the State Merit System by the Civil Service Commission within six months after grant approval.

(d) Revision of various regulations, including those pertaining to employee access to information on their exposure to toxic materials or harmful physical agents and contests before the Review Commission will be undertaken within six months after plan approval.

(e) Submission of amendments to KRS Chapter 338 in 1974 General Assembly, to provide temporary variance authority and incorporate in that chapter penalties for willful violations causing death.

Completion of Developmental Steps and Certification

1952.232

(a) The Kentucky safety and health poster for private and public employees was approved by the Assistant Secretary on May 20, 1976.

(b) Amendments to the Kentucky enabling legislation were enacted to include (1) a division of occupational safety and health compliance and a division of education and training; and (2) authority and procedures for granting temporary variances. Penalties for willful violations causing death of an employee are also covered.

(c) An amended Kentucky Administrative Procedure Act provides procedures for promulgation of standards and administrative regulations including emergency temporary standards.

(d) Kentucky regulations governing recordkeeping and reporting, inspections, citations, proposed penalties, and variances were initially approved with the state plan on July 31, 1973. These regulations were expanded to provide for (1) penalties for failure to correct violations; (2) mandatory penalties for failure to post a citation; (3) procedures for petition for modification of abatement dates; and (4) procedures for granting temporary variances. Kentucky also adopted regulations pertaining to employee access to information on exposure to toxic materials or harmful physical agents.

(e) A manual management information system was implemented in July, 1975 and converted to an automated system in July, 1977.

(f) The personnel operations of the Kentucky Department of Labor and the servicing merit system agency were approved May 17, 1977. Also, the Kentucky Department of Labor affirmative action plan to promote equal employment opportunity was judged acceptable February 12, 1979.

(g) Revised regulations governing the operation of the Kentucky Occupational Safety and Health Review Commission were promulgated in December, 1975.

(h) A revised Kentucky compliance manual was initially submitted in July, 1976 and amended in response to federal comment December 20, 1976.

(i) The governor of Kentucky made the following changes in the organization of the Kentucky Occupational Safety and Health program:

   (1) All occupational health functions except laboratory services were transferred from the Kentucky Department of Human Resources to the Kentucky Department of Labor (May 15, 1974).

   (2) Responsibilities for coverage of public utilities employees were transferred from the Kentucky Public Service Commission to the Kentucky Department of Labor (June 30, 1977).

(j) A Kentucky public employee plan was adopted by the state.

(k) The Kentucky occupational safety and health plan received certification, effective February 8, 1980, as having completed all developmental steps. This certification attests to structural completion, but does not render judgement on adequacy of performance.

Compliance Staffing Benchmarks

1952.233

Compliance staffing levels necessary for a "fully effective" enforcement program needed to be established for each state operating an approved state plan. In September 1984, Kentucky in conjunction with OSHA, completed a reassessment of the levels initially established in 1980 and proposed revised compliance staffing benchmarks of 23 safety and 14 health compliance officers. After opportunity for public comment and service on the AFL-CIO, the Assistant Secretary approved these revised staffing requirements on June 13, 1985.

Final Approval Determination

1952.234

After determining that Kentucky met the "fully effective" compliance staffing benchmarks as revised in 1984 and that the state was providing reports to OSHA through participation in the federal-state unified management information system, the Assistant Secretary evaluated operations under the Kentucky state plan for at least one year following certification. Based on the evaluation report and after opportunity for public comment, the Assistant Secretary determined that the Kentucky state occupational safety and health plan was at least as effective as the federal program in providing safe and healthful employment and places of employment and meets the criteria for final state plan approval. Accordingly, the Kentucky state plan was granted final approval and concurrent federal enforcement authority was relinquished effective June 13, 1985.

(b) The plan covers all activities of employers and all places of employment in Kentucky except for private sector maritime; Tennessee Valley Authority facilities, and on all military bases as well as any other U.S. government properties.

(c) Kentucky is required to maintain a state program which is at least as effective as the federal program; to submit plan supplements; to allocate sufficient safety and health enforcement staff to meet benchmarks for state staffing established by the U.S. Department of Labor, or any revision to those benchmarks; and to furnish such reports in such form as the Assistant Secretary may from time to time require.

Level of Federal Enforcement

1952.235

(a) As a result of the granting of final approval to the Kentucky plan effective June 13, 1985, occupational safety and health standards which have been promulgated under section 6 of the Act do not apply with respect to issues covered under the Kentucky plan. This determination also relinquishes concurrent federal OSHA authority to issue citations for violation of such standards under section 5(a)(2) and 9 of the Act; to conduct inspections and investigations under section 8 [except those necessary to conduct evaluation of the plan under section 18(f) and other inspections, investigations, or proceedings necessary to carry out federal responsibilities not preempted by section 18(e)]; to conduct enforcement proceedings in contested cases under section 10; to institute proceedings to correct imminent dangers under section 13; and to propose civil penalties or initiate criminal proceedings for violations of the federal act under section 17. The Assistant Secretary retains jurisdiction under the above provision in any proceeding commenced under section 9 or 10 before June 13, 1985.

(b) Final approval relinquishes federal OSHA authority only with regard to occupational safety and health issues covered by the Kentucky plan. OSHA retains full authority over issues which are not subject to state enforcement. Thus federal OSHA retains its authority relative to safety and health in private sector maritime activities and will continue to enforce all provisions of the Act, rules or orders, and all federal standards, current or future, specifically directed to private sector maritime employment (29 CFR Part 1915, shipyard employment; Part 17, marine terminals; Part 1918, longshoring; and Part 1919, gear certification) as well as provisions of general industry standards appropriate to hazards found in these employments; employment at Tennessee Valley Authority facilities and on all military bases as well as

any other properties ceded to the U.S. government. Federal jurisdiction is retained with respect to federal government employers and employees. In addition, any hazard, industry, geographical area, operation or facility over which the state is unable to effectively exercise jurisdiction for reasons not related to the required performance or structure of the plan shall be deemed to be an issue not covered by the finally approved plan and shall be subject to federal enforcement. Where enforcement jurisdiction is shared between federal and state authorities, in the interest of administrative practicability, federal jurisdiction may be assumed. In either of the two above circumstances, federal enforcement may be exercised immediately upon agreement between the federal and state OSHA.

(c) Federal authority under provisions of the Act not listed in section 18(e) is unaffected by final approval of the plan. Thus, for example, the Assistant Secretary retains his authority under section 11(c) of the Act with regard to complaints alleging discrimination against employees who exercise any right afforded to them by the Act, although such complaints may be referred to the state for investigation. The Assistant Secretary also retains the authority to promulgate, modify, or revoke occupational safety and health standards which address the working conditions of all employees, including those in states which have received a final approval determination, although such standards may not be federally applied. In the event that the state's 18(e) status is subsequently withdrawn, and federal authority reinstated, all federal standards including any standards promulgated or modified during the 18(e) period would be federally enforceable in that state.

(d) OSHA will continue to monitor the operations of the Kentucky state program to assure that the provisions of the state plan are substantially complied with and that the program remains at least as effective as the federal program. Failure by the state to comply with its obligations may result in the revocation of the final determination under section 18(e), resumption of federal enforcement and/or proceedings for withdrawal of plan approval.

Where the Plan May be Inspected

1952.236

A copy of the principal documents comprising the plan may be inspected and copied during normal business hours at the following locations: Office of State Programs, Occupational Safety and Health Administration, U.S. Dept. of Labor, 200 Constitution Avenue, NW., Room N3476, Washington D.C. 20210; Office of the Regional Administrator, Occupational Safety and Health Administration, U.S. Dept. of Labor, 1375 Peachtree St., NE, Suite 587, Atlanta GA 30309; and Office of the Secretary, Kentucky Labor Cabinet, U.S. Highway 127 South, Frankfort KY 40601.

MARYLAND

MARYLAND STATE PLAN OVERVIEW

The Maryland state occupational safety and health plan received OSHA approval July 5, 1973, and was certified as having completed its developmental steps February 15, 1980. After determining the plan to be at least as effective as the federal OSHA standards, OSHA granted the Maryland plan final approval effective July 18, 1985. The plan is enforced by the Commissioner of Labor and Industry.

The plan covers all worksites except private industry maritime activities, federal government employees, military bases, and employees whose safety is regulated by other federal agencies such as the Nuclear Regulatory Commission.

Maryland adopted state standards identical to federal standards on general industry, construction, and agriculture. The plan also incorporates the American National Standards Institute Safety Code for Elevators, Dumbwaiters, and Escalators, and the Maryland Boiler Safety Act. In addition to adding a special provision requiring a standby employee for employees performing hazardous work in manholes, Maryland has also enacted the Maryland Access to Information about Hazardous and Toxic Substances Act, an employee "right to know" act.

Description of the Plan as Initially Approved

1952.210

(a) The Division of Labor and Industry in the Department of Licensing and Regulation is the state agency designated by the governor to administer the plan throughout the state. The plan defines the covered occupational safety and health issues on the basis of major groups in the Standard Industrial Classification (SIC) Manual of the Office of Management and Budget of the Executive Office of the President. The Commissioner of the Division of Labor and Industry promulgated the federal standards existing as of February 2, 1973. These standards were effective in Maryland as of March 8, 1973, and they will be enforced according to current state legislative authority prior to the effective date of Maryland's enabling legislation, July 1, 1973. Maryland also intends to adopt those federal standards applicable to ship repairing, shipbuilding, shipbreaking and longshoring except where prohibited by exclusive federal maritime jurisdiction. Subsequent revisions to federal standards will be considered by the state Occupational Safety and Health Advisory Board which will make recommendations on adoption of at least as effective standards to the commissioner within six months after federal promulgation. Maryland also includes in its plan state boiler and elevator standards where applicable.

(b) (1) The plan included draft legislation which has been passed by the state legislature and signed by the governor. The legislation as enacted has been included as a supplement to the plan. Under the legislation, effective July 1, 1973, the Division of Labor and Industry in the Department of Licensing and Regulation has full authority to enforce and administer laws respecting safety and health of employees in all workplaces of the state, including coverage of public employees, with the exception of maritime workers in the areas of exclusive federal jurisdiction; employees of the United States; and employees whose working conditions are protected under other federal laws.

(2) The legislation brings the plan into conformity with the requirements of 29 CFR Part 1902 in areas such as procedures for granting or denying temporary and permanent variances to rules, regulations or standards by the commissioner; protection of employees from hazards including provision for medical examinations made available by the employer or at his cost; procedures for the development of standards by the Occupational Safety and Health Advisory Board; promulgation of these standards as recommended by the commissioner; promulgation of emergency temporary standards by the commissioner with referral to the board to develop a permanent standard; procedures for prompt restraint or elimination of imminent danger situations by issuance of a "red-tag" order with court review as well as by court injunction.

(3) The legislation provides for inspections in response to complaints; gives employer and employee representatives an opportunity to accompany inspectors in order to aid inspections; notification of employees or their representatives when no compliance action is taken as a result of alleged violations, including informal review; protection of employees against discharge or discrimination in terms and conditions of employment by filing complaints with the commissioner who will seek court action; adequate safeguards to protect trade secrets; provision for prompt notice to employers and employees of alleged violations of standards and abatement requirements through the issuance and posting of citations; a system of sanctions against employers for violations of standards; employer right of review and employee participation in review proceedings before the commissioner with subsequent judicial review; and coverage of employees of the state and political subdivisions in a separate program supervised by the commissioner in accordance with the requirements described in the North Carolina decision (38 FR 3041).

(c) Included in the plan is a legal opinion that the law, which was supported by the governor in accordance with the requirements of Part 1902, meets the requirements of the Occupational Safety and Health Act of 1970 and is consistent with the constitution and laws of Maryland. The plan sets out goals and provides a timetable for bringing it into full conformity with Part 1902 at the end of three years after the commencement of operations under the plan. Personnel will be employed under the existing state merit system with the revisions in qualifications as stated in supplements to the plan, and the voluntary compliance program for onsite consultation meets the conditions set forth in the issues discussed in the Washington decision (38 F.R. 2421).

Developmental Schedule

1952.211

(a) Occupational health study accepted and implementation begun July 1973;

(b) Compliance manual developed by July 1973;

(c) Management information system, December 1975;

(d) Training in compliance procedures by August 1973;

(e) Promulgation of standard-setting procedures, August 1973;

(f) Inspection and enforcement program, except as provided in paragraph (k), in September 1973;

(g) Staff of hearing examiners and review procedures set up in September 1973;

(h) Variance procedures and emergency temporary standard-setting procedures promulgated October 1973;

(i) Review of appeal procedures to see if it should be continued or modified, July 1974;

(j) Review of job qualifications within one year of plan approval;

(k) Inspection and enforcement program in agriculture and agreement with the State Department of Agriculture operational, December 1974;

(l) Fully operational occupational health program, July 1975;

(m) Fully implemented public employees program, December 1975;

Completion of Developmental Steps and Certification

1952.214

(a) The Maryland occupational safety and health standards were approved by the Assistant Regional Director on October 3, 1974.

(b) The Maryland state poster was approved by the Assistant Secretary on June 6, 1975.

(c) The state of Maryland developed and implemented an occupational health plan by December 31, 1975.

(d) The designee developed a fully operational management information system by May 1, 1975.

(e) Training of Maryland compliance personnel in compliance procedure was completed by December 31, 1975.

(f) The Maryland inspection and enforcement program was implemented by September 1973.

(g) Review of the appeal procedures to see if they should be continued or modified was conducted by the state by May 1975.

(h) Maryland completed development of a compliance manual.

(i) The state has promulgated acceptable standard-setting procedures.

(j) Maryland promulgated acceptable variance procedures and emergency temporary standard setting procedures.

(k) Review of the job qualifications of state personnel was conducted by the state.

(l) The state of Maryland has developed and implemented a safety and health program for public employees.

(m) The state submitted an occupational health study, and the state's occupational health plan is being implemented.

(n) The state established a staff of hearing examiners and review procedures.

(o) Agricultural standards are being enforced by the Maryland Department of Labor and Industry.

(p) The Maryland occupational safety and health plan was certified as having completed all developmental steps effective February 15, 1980. This certification attests to structural completion but does not render judgement on adequacy of performance.

Compliance Staffing Benchmarks

1952.213

Compliance staffing levels (benchmarks) necessary for a "fully effective" enforcement program needed to be established for each state operating an approved state plan. In September, 1984, Maryland in conjunction with OSHA completed a reassessment of the levels initially established in 1980 and proposed revised compliance staffing benchmarks of 36 safety and 18 health compliance officers. These revised staffing requirements were approved by the Assistant Secretary effective July 18, 1985.

Final Approval Determination

1952.214

(a) After determining that Maryland met the "fully effective" compliance staffing benchmarks as revised in 1984 and that the state was providing reports to OSHA through participation in the federal-state unified management information system, the Assistant Secretary evaluated operations under the Maryland state plan for at least one year following certification. Based on the evaluation report and after opportunity for public comment, the Assistant Secretary determined that the Maryland state occupational safety and health plan was at least as effective as the federal program in providing safe and healthful employment and places of employment and meets the criteria for final state plan approval. Accordingly, the Maryland state plan was granted final approval and concurrent federal enforcement authority was relinquished effective July 18, 1985.

(b) The plan covers all activities of employers and all places of employment in Maryland except for private sector maritime and on military bases.

(c) Maryland is required to maintain a state program which is at least as effective as the federal program; to submit plan supplements; to allocate sufficient safety and health enforcement staff to meet benchmarks for state staffing established by the U.S. Department of Labor, or any revision to those benchmarks; and to furnish such reports in such form as the Assistant Secretary may from time to time require.

Level of Federal Enforcement

1952.215

(a) As a result of the granting of final approval to the Maryland plan effective July 18, 1985, occupational safety and health standards which have been promulgated under section 6 of the Act do not apply with respect to issues covered under the Maryland plan. This determination also relinquishes concurrent federal OSHA authority to issue citations for violation of such standards under section 5(a)(2) and 9 of the Act; to conduct inspections and investigations under section 8 [except those necessary to conduct evaluation of the plan under section 18(f) and other inspections, investigations, or proceedings necessary to carry out federal responsibilities not preempted by section 18(e)]; to conduct enforcement proceedings in contested cases under section 10; to institute proceedings to correct imminent dangers under section 13; and to propose civil penalties or initiate criminal proceedings for violations of the federal act under section 17. The Assistant Secretary retains jurisdiction under the above provision in any proceeding commenced under section 9 or 10 before July 18, 1985.

(b) Final approval relinquishes federal OSHA authority only with regard to occupational safety and health issues covered by the Maryland plan. OSHA retains full authority over issues which are not subject to state enforcement. Thus federal OSHA retains its authority relative to safety and health in private sector maritime activities and will continue to enforce all provisions of the Act, rules or orders, and all federal standards, current or future, specifically directed to private sector maritime employment (29 CFR Part 1915, shipyard employment; Part 17, marine terminals; Part 1918, longshoring; and Part 1919, gear certification) as well as provisions of general industry standards appropriate to hazards found in these employments and on military bases. Federal jurisdiction is also retained with respect to federal government employers and employees. In addition, any hazard, industry, geographical area, operation or facility over which the state is unable to effectively exercise jurisdiction for reasons not related to the required performance or structure of the plan shall be deemed to be an issue not covered by the finally approved plan and shall be subject to federal enforcement. Where enforcement jurisdiction is shared between federal and state authorities, in the interest of administrative practicability, federal jurisdiction may be assumed. In either of the two above circumstances, federal enforcement may be exercised immediately upon agreement between the federal and state OSHA.

(c) Federal authority under provisions of the Act not listed in section 18(e) is unaffected by final approval of the plan. Thus, for example, the Assistant Secretary retains his authority under section 11(c) of the Act with regard to complaints alleging discrimination against employees who exercise any right afforded to them by the Act, although such complaints may be referred to the state for investigation. The Assistant Secretary also retains the authority to promulgate, modify, or revoke occupational safety and health standards which address the working conditions of all employees, including those in states which have received a final approval determination, although such standards may not be federally applied. In the event that the state's 18(e) status is subsequently withdrawn, and federal authority reinstated, all federal standards including any standards promulgated or modified during the 18(e) period would be federally enforceable in that state.

(d) OSHA will continue to monitor the operations of the Maryland state program to assure that the provisions of the state plan are substantially complied with and that the program remains at least as effective as the federal program. Failure by the state to comply with its obligations may result in the revocation of the final determination under section 18(e), resumption of federal enforcement and/or proceedings for withdrawal of plan approval.

Where the Plan May Be Inspected

1952.216

A copy of the principal documents comprising the plan may be inspected and copied during normal business hours at the following locations: Office of State Programs, Occupational Safety and Health Administration, U.S. Dept. of Labor, 200 Constitution Avenue, NW., Room N3476, Washington D.C. 20210; Office of the Regional Administrator, Occupational Safety and Health Administration, U.S. Dept. of Labor, Gateway Building - Suite 2100, 3535 Market St., Philadelphia PA 19104; and Office of the Commissioner, Maryland Division of Labor and Industry, Dept. of Licensing and Regulation , 501 St. Paul Place, Baltimore MD 21202.

MICHIGAN

MICHIGAN STATE PLAN OVERVIEW

The Michigan state occupational safety and health plan was approved October 3, 1973 and granted operational status January 7, 1977. In 1981, the state was certified by OSHA as having completed its developmental steps. Safety standards under the plan are enforced by the Michigan Department of Labor, while health standards are enforced by the Michigan Department of Public Health.

The plan covers all industrial activities except maritime industries, domestic employment, and mines. While Michigan adopted many of the federal OSHA general industry, construction, and agriculture standards, it also retained many job safety and health standards which were in effect prior to the formation of OSHA. Special provisions include regulations for pressurized tunnel construction, personal protective equipment, and chemical manufacturing.

Description of the Plan as Initially Approved:

1952.260

(a) The plan identifies the Michigan Department of Labor and the Department of Public Health as the agencies to be responsible for administering the plan throughout the state. The Department of Labor will be responsible for promulgating and enforcing general safety and construction safety standards while the Department of Public Health will be responsible for the promulgation and enforcement of occupational health standards. Two independent commissions within the Department of Labor, the Construction Safety and Commission and the Occupational Safety Standards Commission will promulgate general and construction safety standards while the Director of Public Health will promulgate health standards. Applications for variances to standards will be handled by the two departments. Administrative adjudications will be the responsibility of the Occupational Safety Compliance and Appeals Board, the Construction Safety Compliance and Appeals Board, and the Occupational Health Review Commission.

(b) The state progam is expected to extend its protection to all employees in the state (including those employed by it and its political subdivisions) except those employed by federal agencies, maritime workers, household domestic workers, and mine workers.

(c) The plan gives the state agencies full authority to administer and to enforce all laws, rules and orders protecting employee safety and health in all places of employment in the state. It also proposes procedures for providing prompt and effective standards for the protection of employees against new and unforeseen hazards, and for furnishing information to employees on hazards, precautions, symptoms, and emergency treatment, and procedures for variances and the protection of employees from hazards. It further provides employer and employee representatives an opportunity to accompany inspectors and call attention to possible violations before, during and after inspections; protection of employees against discharge or discrimination in terms and conditions of employment; notice to employees or their representatives when no compliance action is taken upon complaints, including informal review; notice to employees of their protections and obligations; adequate safeguards to protect trade secrets; prompt notice to employers and employees of alleged violations of standards and abatement requirements; effective remedies against employers; and the right to review alleged violations, abatement periods, and proposed penalties with opportunity for employee participation in the review proceeding; procedures for prompt restraint or elimination of imminent danger conditions; provision for the issuance of cease operation orders in cases where employers fail to comply with final orders for abatement; and provision for inspections in reponse to complaints.

(d) The state intends to promulgate standards for all of the issues contained in 29 CFR Part 1910 and 1926 with the exception of ship repairing, shipbuilding, shipbreaking and longshoring, which standards are to be as effective as federal standards. Michigan had originally not intended to promulgate a standard

covering cooperage machinery comparable to 29 CFR 1910.214, but it has now provided assurances that it will promulgate such a standard if the hazards covered by the federal cooperage standard are found to exist in Michigan. The state has already promulgated standards as effective as subparts F, K, M, Q and S and the remaining subparts are to be covered by state standards which are to be promulgated by June 1975.

(e) The plan includes a statement of the governor's support for the proposed legislation and a statement of legal opinion that it will meet the requirements of the Occupational Safety and Health Act of 1970, and is consistent with the constitution and laws of Michigan. The plan sets out goals and provides a timetable for bringing it into full conformity with Part 1902 of this title upon enactment of the proposed legislation by the state legislature. A merit system of personnel administration will be used. In addition, health and safety education and training programs are to be carried on for the benefit of employers and employees. The Department of Labor will also be conducting a safety director program wherein companies which are found to have high injury incident rates will be assisted in developing safety programs.

Where the Plan May Be Inspected

1952.261

A copy of the plan may be inspected and copied during normal business hours at the following locations: Office of Federal and State Operations, Occupational Safety and Health Administration, Room 800, 1726 M Street, N.W., Washington, D.C. 20210; Regional Office, Occupational Safety andh Health Administration, 300 South Wacker Drive, Chicago IL 60606; Michigan Department of Labor, Bureau of Safety and Regulation, 2nd Floor, 300 East Michigan Avenue, Lansing MI 48926; Michigan Department of Public Health, Division of Occupational Health, Media Building, 2nd Floor, 3500 North Logan Street, Lansing MI 48114.

Level of Federal Enforcement

1952.262

Effective January 6, 1977, Michigan is operational in the issues covered by the Michigan occupational safety and health plan. The U.S. Department of Labor will continue to exercise authority, among other things, with regard to: complaints about violations of the discrimination provisions of section 11(c) of the Act (29 U.S.C. 660(c)); federal standards promulgated subsequent to the agreement where necessary to protect employees, as in the case of temporary emergency standards promulgated under section 6(c) of the Act (29 U.S.C 655(c)), in the issues covered under the plan and the agreement until such time as Michigan shall have adopted equivalent standards in accordance with Subpart C of 29 CFR Part 1953; standards which have been specifically excluded from coverage under the Michigan plan; investigations and inspections for the purpose of the evaluation of the Michigan plan. The Regional Administrator for Occupational Safety and Health will make a prompt recommendation for resumption of the exercise of federal enforcement authority whenever, and to the degree necessary to assure occupational safety and health protection to employees in the state of Michigan.

Developmental Schedule

1952.263

(a) Enactment of the Michigan Occupational Safety and Health Act by December 1973.

(b) Promulgation of occupational safety and health standards as effective and comprehensive as those set forth in Chapter XVII of this Title 29 of the Code of Federal Regulations by June 1975.

(c) Completion of the Michigan compliance manual within one year after passage of the state legislation.

(d) Promulgation of regulations similar to Parts 1903, 1905 and 2200 of this title within one year after passage of the state legislation.

(e) Promulgation of 29 CFR Part 1904 as a state regulation, including any amendments to Part 1904, within one (1) year following passage of the proposed legislation.

(f) Development of a new coordination agreement between the Michigan Departments of Labor and Public Health within three months following the passage of the proposed state legislation.

(g) Implementation of the state's public employee program within one year following passage of the proposed legislation.

(h) Within three years of plan approval all developmental steps will be fully implemented.

(i) The Michigan safety and health plan was certified as having completed all developmental steps, effective January 13, 1981.

Completed Developmental Steps

1952.264

(a) The Michigan Occupational Safety and Health Act was enacted on June 18, 1974 and is effective January 1, 1975. This legislation, Act 154 of Michigan Public Acts of 1974, was submitted to the Assistant Secretary on June 19, 1974 and approved on February 21, 1975.

(b) The Michigan Department of Labor and the Michigan Department of Public Health have entered into a new interagency agreement on September 23, 1974. The agreement was submitted to the Assistant Secretary on October 28, 1974 and approved on February 21, 1975.

(c) The Michigan state poster was approved by the Assistant Secretary on September 22, 1975.

(d) Michigan's public employee program was implemented with an effective date of July 1, 1975, and approved by the Assistant Secretary on October 17, 1977.

(e) Procedural rules for the granting of variances, regulations for inspections and investigations, citations, and proposed penalties, and procedural rules for the Board of Health and Safety Compliance and Appeals were approved by the Assistant Secretary January 12, 1981.

(f) The Michigan Occupational Safety and Health Act was approved (as amended in 1979) by the Assistant Secretary on January 12, 1981.

(g) Manuals for compliance operations of the Michigan Department of Labor and Public Health were approved by the Assistant Secretary on January 13, 1981.

(h) Rules for recording and reporting of occupational injuries and illnesses were approved by the Assistant Secretary on January 13, 1981.

MINNESOTA

MINNESOTA STATE PLAN OVERVIEW

The Minnesota state occupational safety and health plan was approved June 8, 1973 and declared operational August 1, 1973. The plan was certified as having completed all developmental steps September 28, 1976. After determining the plan was at least as effective as federal OSHA standards, OSHA granted final approval July 30, 1985. The plan is enforced by the Minnesota Department of Labor and Industry.

The state has adopted all the federal occupational safety and health standards including general industry, agriculture, construction, and maritime. A number of state standards are also enforced, which include requirements for steam boilers, elevators, dumbwaiters, escalators, and moving walks, among other requirements. In 1983, Minnesota also enacted an employee right to know act which requires employers to train employees routinely exposed to hazardous substances.

The Minnesota plan applies to all employments except offshore maritime industries, employment with the Twin Cities Army Ammunition plant, and workplaces under the exclusive jurisdiction of the federal government.

Description of the Plan as Initially Approved

1952.200

(a) The Department of Labor and Industry is the state agency designated by the governor to administer the plan throughout the state. The plan defines the covered occupational safety and health issues as defined by the Secretary of Labor in 29 CFR 1902.2(c)(1). The commissioner of the Department of Labor and Industry adopted federal standards promulgated as of October 1972, effective in Minnesota February 1973. The commissioner will continue to adopt federal standards and will retain those Minnesota standards not covered by federal standards. The plan contains a list of the federal standards adopted and the state standards that will be retained. These standards will be enforced according to current legislative authority in Minnesota prior to the effective date of Minnesota's enabling legislation submitted as part of the plan.

(b) (1) The plan includes legislation enacted by the Minnesota legislature during its 1973 session. Under the legislation the Department of Labor and Industry will have full authority to enforce and administer laws respecting safety and health of employees in all workplaces of the state, including coverage of public employees, with the exception of maritime workers in the areas of exclusive federal jurisfiction, employees of the United States, and employees whose working conditions are regulated by federal agencies other than the U.S. Department of Labor.

(2) The legislation further proposed to bring the plan into conformity with the requirements of 29 CFR, part 1902 in areas such as procedures for granting or denying temporary and permanent variances by the commissioner; including emergency temporary standards; and procedures for prompt restaint or elimination of imminent danger situations by issuance of a "red-tag" order effective for three days as well as by court injunction.

(3) The legislature is also intended to insure inspections in response to compliants; give employer and employee representatives an opportunity to accompany inspector in order to aid inspections and that loss of any privilege or payment to an employee as a result of aiding such inspection would constitute discrimination; notification of employees of their representatives where no compliance action is taken as a result of alleged violations, including informal review; notification of employees of their protections and obligations; protection of employees against discharge or discrimination in terms and conditions of employment of filing complaints with the commissioner and hearings by the review commission; adequate safeguards to protect trade secrets; provision for prompt notice to employers and employees of alleged violations of standards and abatement requirements through the issuance and posting of citations; a system of sanctions against

employers for violation of standards; employer right or review and employee participation in review proceedings before an independent review commission; and coverage of employees of the state and political subdivisions in the same manner as private employees.

(c) Included in the plan is a statement of the governor's support for the legislation and a statement of legal opinion that it will meet the requirements of the Occupational Safety and Health Act of 1970 and is consistent with the constitution and laws of Minnesota. The plan sets out goals and provides a timetable for bringing it into full conformity with part 1902 at the end of three years after commencement of operations under the plan. Personnel will be employed under the existing state merit system and the voluntary compliance program for onsite consultation for private and public employers meets the conditions set forth in the issues dicussed in the Washington decision (38 F.R. 2421, January 26, 1973).

Developmental Schedule

1952.201

(a) Retraining of present occupational safety and health personnel during March—May 1973;

(b) Training sessions for public employers and employees during April—June 1973;

(c) Effective date of legislation, August 1, 1973;

(d) Regulations on variances, August 1973;

(e) Management information system, August 1973;

(f) Staff increases in Department of Labor and Industry and Department of Health 1973-74;

(g) Voluntary compliance program implemented by January 1975;

(h) Coverage and enforcement of standards regarding agriculture, July 1975.

Completion of Developmental Steps and Certification:

1952.202

(a) The Minnesota state poster was approved by the Assistant Secretary on March 7, 1975.

(b) The Minnesota voluntary compliance program became effective on January 1, 1975, and was approved by the Assistant Secretary on April 24, 1975.

(c) State occupational safety and health personnel were trained during March — May 1973.

(d) Training sessions for public employers and employees were held during April — June 1973.

(e) The Minnesota enabling legislation became effective on August 1, 1973. In addition, amendments to the legislation which concerned employee discrimination complaints and violations became effective on July 1, 1975, and a second amendment concerning the definition of a serious violation, posting of citations and notices of penalties to employer representatives and, in the case of a fatality, to the next of kin or a designated representative, became effective on August 1, 1975.

(f) Regulations on variances, were promulgated on February 20, 1974, and were approved with assurances by the Assistant Secretary on August 31, 1976.

(g) The management information system became operable in August 1973.

(h) Coverage and enforcement of agricultural standards commenced on July 1, 1975.

(i) The Rules of Procedure of the Minnesota Occupational Safety and Health Review Commission, Chapter 20, Minnesota Occupational Safety and Health Code, and regulations concerning inspections, citations, and proposed penalties, Chapter 21, Minnesota Occupational Safety and Health Code, were approved by the Assistant Secretary on August 31, 1976.

(j) The downward revision of the projected increase in personnel for fiscal year 1976 due to a lesser than anticipated increase of funding by the Minnesota legislature, was approved by the Assistant Secretary as meeting current required staffing on August 31, 1976.

(k) The state poster approved on March 25, 1975 (40 FR 13211) which was revised in response to legislative amendments described above, to provide that citations and notices of penalties must be posted at or near the place of the alleged violation for 15 days or until the violation is corrected, whichever is later, and which lists additional Minnesota area offices, was approved by the Assistant Secretary on August 31, 1976.

(l) The Minnesota occupational safety and health plan was certified, effective September 28, 1976, as having completed all developmental steps specified in the plan as approved on May 29, 1973, on or before June 30, 1976.

Compliance Staffing Benchmarks

1952.203

Compliance staffing levels necessary for a "fully effective" enforcement program needed to be established for each state operating an approved state plan. In September 1984, Minnesota in conjunction with OSHA, completed a reassessment of the levels initially established in 1980 and proposed revised compliance staffing benchmarks of 31 safety and 12 health compliance officers. After opportunity for public comment and service on the AFL-CIO, the Assistant Secretary approved these revised staffing requirements on July 30, 1985.

Final Approval Determination

1952.204

(a) After determining that Minnesota met the "fully effective" compliance staffing benchmarks as revised in 1984 and that the state was providing reports to OSHA through participation in the federal-state unified Management Information System, the Assistant Secretary evaluated operations under the Minnesota state plan for at least one year following certification. Based on the evaluation report and after opportunity for public comment, the Assistant Secretary determined that the Minnesota state occupational safety and health plan was at least as effective as the federal program in providing safe and healthful employment and places of employment and meets the criteria for final state plan approval. Accordingly, the Minnesota state plan was granted final approval and concurrent federal enforcement authority was relinquished effective July 30, 1985.

(b) The plan covers all activities of employers and all places of employment in Minnesota except for private sector offshore maritime and employment at the Twin Cities Army Ammunition plant.

(c) Minnesota is required to maintain a state program which is at least as effective as the federal program; to submit plan supplements; to allocate sufficient safety and health enforcement staff to meet benchmarks for state staffing established by the U.S. Department of Labor, or any revision to those benchmarks; and to furnish such reports in such form as the Assistant Secretary may from time to time require.

Level of Federal Enforcement

1952.205

(a) As a result of the granting of final approval to the Minnesota plan effective July 30, 1985, occupational safety and health standards which have been promulgated under section 6 of the Act do not apply with respect to issues covered under the Minnesota plan. This determination also relinquishes concurrent federal OSHA authority to issue citations for violation of such standards under section 5(a)(2) and 9 of the Act; to conduct inspections and investigations under section 8 [except those necessary to conduct evaluation of the plan under section 18(f) and other inspections, investigations, or proceedings necessary to carry out federal responsibilities not preempted by section 18(e)]; to conduct enforcement proceedings in contested cases under section 10; to institute proceedings to correct imminent dangers under section 13; and to propose civil penalties or initiate criminal proceedings for violations of the federal act under section 17. The Assistant Secretary retains jurisdiction under the above provision in any proceeding commenced under section 9 or 10 before July 30, 1985.

(b) Final approval relinquishes federal OSHA authority only with regard to occupational safety and health issues covered by the Minnesota plan. OSHA retains full authority over issues which are not subject to state enforcement. Thus federal OSHA retains its authority relative to safety and health in private sector offshore maritime activities and will continue to enforce offshore all provisions of the Act, rules or orders, and all federal standards, current or future, specifically directed to private sector maritime employment (29 CFR Part 1915, shipyard employment; Part 17, marine terminals; Part 1918, longshoring; and Part 1919, gear certification) as well as provisions of general industry standards appropriate to hazards found in these employments. Federal jursidiction is also retained at the Twin Cities Army Ammunition plant and with respect to federal government employers and employees. In addition, any hazard, industry, geographical area, operation or facility over which the state is unable to effectively exercise jurisdiction for reasons not related to the required performance or structure of the plan shall be deemed to be an issue not covered by the finally approved plan and shall be subject to federal enforcement. Where enforcement jurisdiction is shared between federal and state authorities, in the interest of administrative practicability, federal jurisdiction may be assumed. In either of the two above circumstances, federal enforcement may be exercised immediately upon agreement between the federal and state OSHA.

(c) Federal authority under provisions of the Act not listed in section 18(e) is unaffected by final approval of the plan. Thus, for example, the Assistant Secretary retains his authority under section 11(c) of the Act with regard to complaints alleging discrimination against employees who exercise any right afforded to them by the Act, although such complaints may be referred to the state for investigation. The Assistant Secretary also retains the authority to promulgate, modify, or revoke occupational safety and health standards which address the working conditions of all employees, including those in states which have received a final approval determination, although such standards may not be federally applied. In the event that the state's 18(e) status is subsequently withdrawn, and federal authority reinstated, all federal standards including any standards promulgated or modified during the 18(e) period would be federally enforceable in that state.

(d) OSHA will continue to monitor the operations of the Minnesota state program to assure that the provisions of the state plan are substantially complied with and that the program remains at least as effective as the federal program. Failure by the state to comply with its obligations may result in the revocation of the final determination under section 18(e), resumption of federal enforcement and/or proceedings for withdrawal of plan approval.

Where the Plan May be Inspected

1952.206

A copy of the principal documents comprising the plan may be inspected and copied during normal business hours at the following locations: Office of State Programs, Occupational Safety and Health Administration, U.S. Dept. of Labor, 200 Constitution Avenue, NW., Room N3476, Washington D.C. 20210; Office of the Regional Administrator, Occupational Safety and Health Administration, U.S. Dept. of Labor, 230 S. Dearborn, 32nd Floor, Chicago IL 60604; and the Minnesota Dept. of Labor and Industry, 444 Lafayette Road, St. Paul MN 55101.

NEVADA

NEVADA STATE PLAN OVERVIEW

The Nevada state occupational safety and health plan was approved January 4, 1974, declared operational July 1, 1974, and certified as having completed all developmental steps as of August 13, 1981. The Department of Occupational Safety and Health of the Nevada Industrial Commission is responsible for enforcing the program.

The plan adopts all federal OSHA standards as state standards, and includes extra provisions for boiler and pressure vessels (produced by the American Society of Mechanical Engineers) and elevator standards (produced by the American National Standards Institute). Another special provision provides access to department records for both employers and employees

The plan covers all workplaces except those regulated by other federal agencies such as the Mine Safety and Health Administration and the Federal Railroad Administration.

Description of the Plan as Initially Approved

1952.290

(a) The Nevada Occupational Safety and Health program will be administered and enforced by the Department of Industrial Safety of the Industrial Commission of the state of Nevada. Administrative adjudications of proposed penalties will be the responsibility of an independent five member review board appointed by the governor.

(b) The program will cover all activities of employees and places of private and public employment except those involving federal employment, motor vehicles, and railroads, subject to the exercise of jurisdiction under other federal safey and health programs. It requires employers of one or more employees (including those employed by the state and its political subdivisions) to furnish them employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm, and to comply with all occupational safety and health standards promulgated or issued by the agency. Moreover, all safety and health standards adopted by the United State Department of Labor shall be deemed Nevada Occupational Safety and Health standards. The plan also directs employees to comply with all occupational safety and health standards and regulations that are applicable to their own actions and conduct.

(c) The plan includes procedures for providing prompt and effective standards for the protection of employees against new and unforeseen hazards and for furnishing information to employees on hazards, precautions, symptoms, and emergency treatment; and procedures for the issuance of variances. It provides employer and employee representatives an opportunity to accompany inspectors and call attention to possible violations, before, during, and after inspections; protection of employees against discharge or discrimination in terms and conditions of employment; notice to employees or their representatives when no compliance action is taken upon compliants, including informal review; notice to employees of their protections and obligations; adequate safeguards to protect trade secrets; prompt notice to employers and employees of alleged violations of standards and abatement requirements; effective remedies against employers and the right to review alleged violations, abatement periods, and proposed penalties with opportunity for employee participation in the review proceedings; procedures for prompt restraint or elimination of imminent danger conditions, and procedures for inspection in response to complaints.

(d) (1) The plan includes a legal opinion that it will meet the requirements of the Occupational Safety and Health Act of 1970, and is consistent with constitution and laws of the state of Nevada.

(2) A merit system of personnel administration will be used.

(3) The plan provides a program of education, training, and consultation for employers and employees.

(4) The plan is supplemented by the inclusion of implementing legislation and letters dated July 26, August 10, and November 5, 1973, and a telegram dated Dec. 5, 1973.

Where The Plan May Be Inspected

1952.291

A copy of the plan may be inspected and copied during normal business hours at the following locations: United States Dept. of Labor, Office of Federal and State Operations, Occupational Safety and Health Administration, Room, 800, 1726 M Street NW., Washington D.C. 20210; Regional Office, Occupational Safety and Health Administration, Room 9470, Federal Office Building, 450 Golden Gate Avenue, San Francisco CA 94102; Department of Occupational Safety and Health, Nevada Industrial Commission, 515 East Musser Street, Carson City NV 89701.

Level of Federal Enforcement

1952.292

Based on a determination that Nevada is operational in the issues covered by the Nevada state occupational safety and health plan, federal enforcement authority will not be initiated with regard to federal occupational safety and health standards. The U.S. Department of Labor will continue to exercise authority with respect to complaints filed alleging discrimination under section 11(c) of the Act; standards in the maritime and longshoring issues covered by 29 CFR Parts 1915, 1916, 1917, 1918, and 1919 (ship building, shipbreaking, ship repairing, longshoring, and gear certification), which have been specifically excluded from coverage under the plan; enforcement relating to any contractors or subcontractors on any federal establishment where the state cannot obtain entry; enforcement of new federal standards until the state adopts a comparable standard; situations where the state is refused entry and is unable to obtain a warrant or enforce the right of entry; enforcement of unique and complex standards as determined by the Assistant Secretary; situations when the state is temporarily unable to exercise its enforcement authority fully or effectively completion of enforcement actions initiated prior to the effective date of the agreement; and investigations and inspections for the purpose of evaluating the Nevada plan. The Regional Administrator for Occupational Safety and Health will make a prompt recommendation for the resumption of federal enforcement authority whenever, and to the degree necessary to assure occupational safety and health protection to employees in Nevada.

Developmental Schedule

1952.293

The following is a summary of the major developmental steps provided by the plan:

(a) Training of enforcement personnel to be completed — July 1, 1974.

(b) Application of the program to state and local employees to take effect — July 1, 1974.

(c) Not less than two industrial hygiene experts shall participate in the program — July 1, 1975.

(d) Proposed amendments to the Nevada Occupational Safety and Health Act to have been adopted and to take effect — July 1, 1975.

(e) System of recordkeeping and reporting fully developed and operational — January 1, 1977.

(f) Program to be fully implemented — January 1, 1977.

Completion of Developmental Steps and Certification

1952.294

(a) A separate and autonomous on-site consultation program became effective on July 1, 1975, and was approved by the Assistant Secretary on February 26, 1976.

(b) The Nevada health program was submitted on December 3, 1976 and has been implemented.

(c) The Nevada poster for private employers was approved by the Assistant Secretary on December 23, 1977.

(d) Initial training of Nevada personnel has been completed.

(e) Nevada began participation in the Bureau of Labor Statistics annual survey of occupational injuries and illnesses on July 19, 1976.

(f) Standards identical to federal standards promulgated through January 18, 1977 were adopted by the state and approved by the Regional Administrator in the notice published by the Federal Register on July 26, 1977 (42 FR 38026).

(g) Regulations concerning the rules of occupational safety and health recordkeeping requirements were submitted September 16, 1979, revised effective January 9, 1981, and approved by the Assistant Secretary August 13, 1981.

(h) Regulations concerning the rules of procedures of the Occupational Safety and Health Commission; rules of practice for variances; and rules for inspections, citations, and proposed penalties were submitted June 24, 1975, revised effective January 9, 1981, and approved by the Assistant Secretary August 13, 1981.

(i) Regulations concerning the public employee program were submitted June 24, 1975, revised effective February 15, 1979, and approved by the Assistant Secretary August 13, 1981.

(j) The revised poster was submitted April 7, 1980, and approved by the Assistant Secretary on August 13, 1981.

(k) Amendments to the state's legislation were submitted June 24, 1975, and July 1, 1977; became effective on July 1, 1975 and July 1, 1977, and approved by the Assistant Secretary on August 13, 1981.

(l) The Nevada field operations manual was submitted June 24, 1975, revised to reflect changes made in the federal field operations manual through March, 1981, and approved by the Assistant Secretary on August 13, 1981.

(m) The Nevada occupational safety and health plan was certified as having completed all developmental steps on August 13, 1981. This certification attests to structural completion but does not render judgement on adequacy of performance.

Changes to Approved Plans

1952.295

The Nevada industrial hygiene field operations manual was submitted on December 18, 1980 and approved October 20, 1981.

NEW MEXICO

NEW MEXICO STATE PLAN OVERVIEW

The New Mexico state occupational safety and health plan was approved July 2, 1976, declared operational July 2, 1976, and certified as having completed all developmental steps effective December 4, 1984. The plan is enforced by the Environmental Improvement Division of the Health and Environment Department.

The plan covers all workplaces except the maritime industry, coke oven emissions standards, or areas covered by other federal agencies such as the Mine Safety and Health Administration. The state adopted all federal OSHA standards on general industry, construction, and agriculture, with the exception of those on lead and benzene (the federal benzene standard was later struck down).

Desciption of the Plan as Initially Approved:

1952.360

(a) (1) The plan identifies the New Mexico Environmental Improvement Agency, with its subordinate organization, the Occupational and Radiation Protection Division, as the state agency designated to administer the plan throughout the state. It adopts the definition of occupational safety and health issues expressed in §1909.02(c)(1) of this chapter. The state has adopted the federal field operations manual and all the federal standards except those found in 29 CFR Parts 1915, 1916, 1917, and 1918 (ship repairing, shipbuilding, shipbreaking, and longshoring). In addition, the Occupational and Radiation Protection Division will be enforcing state standards under the Radiation Protection Act (Chp. 284, Law of 1971, 12-9-1, through 12-9-11, New Mexico Statutes Annotated). However, since this Act provides protection to the general public, in the event of conflict between Radiation Protection Act standards and occupational safety and health standards, employees will receive the protection provided under the more stringent regulation.

(2) The plan provides a description of personnel employed under a merit system; the coverage of employees of political subdivisions; procedures for the development and promulgation of standards, including standards for the protection of employees against new and unforeseen hazards; and procedures for the prompt restraint of immiment danger situations.

(b) (1) The plan includes legislation enacted by the New Mexico legislature during its 1975 legislative session amending Chp. 63, Laws of 1972, 59-14-1 through 59-14-23 of the New Mexico Statutes Annotated to bring them into conformity with the requirements of Part 1902 of this chapter. Under the legislation, the Environmental Improvement Agency will have full authority to enforce and administer laws respecting the safety and health of employees in all workplaces of the state.

(2) The legislation is intended, among other things, to assure inspections in response to employee complaints; give employer and employee representatives an opportunity to accompany inspectors in order to aid inspections; notify employees of their protections and obligations; protect employees against discharge or discrimination in terms and conditions of employment; provide adequate safeguards to protect trade secrets; impose sanctions against employers for violations of standards and orders; insure employer right of review to an Occupational Health and Safety Review Commission and then the courts, and employee participation in the review proceedings. The plan also proposes a program of voluntary compliance by employers and employees, including a provision for onsite consultation. The state's consultation program will not detract from its enforcement program and the state's consultation program will meet the conditions set forth in the Washington decision (38 FR 2421, January 26, 1973).

(c) The New Mexico plan includes the following documents as of the date of approval:

(1) The plan description documents, in one volume.

(2) A copy of the enabling legislation as amended by the state legislature in its 1975 session.

(3) A letter from Aaron Bond, Director of the New Mexico Environmental Improvement Agency, to Barry J. White, Associate Assistant Secretary for Regional Programs, dated November 4, 1975, submitting information, clarification, and revisions on several issues raised during the review process, including proposals to be submitted to the New Mexico legislature prior to the close of its 1977 legislative session.

Where the Plan May Be Inspected

1952.361

A copy of the plan may be inspected and copied during normal business hours at the following locations: Office of the Associate Assistant Secretary for Regional Programs, New Department of Labor Building, Room N3608, 200 Constitution Ave., N.W., Washington D.C. 20210; The Technical Data Center, Occupational Safety and Health Administration, New Department of Labor Building, Room N3620, 200 Constitution Ave., N.W., Washington D.C. 20210; Assistant Regional Director, Occupational Safety and Health Administration, 555 Griffin Square Building, Griffin and Young Streets, Dallas TX 75202; and the Director, Environmental Improvement Agency, State of New Mexico, P.O. Box 2348, PERA Building, Room 506, Santa Fe NM 87503.

Level of Federal Enforcement:

1952.362

Based on a determination that New Mexico is operational in the issues covered by the New Mexico state occupational safety and health plan, federal enforcement authority will not be initiated with regard to federal occupational safety and health standards. The U.S. Department of Labor will continue to exercise authority with respect to complaints filed alleging discrimination under section 11(c) of the Act; standards in the maritime and longshoring issues covered by 29 CFR Parts 1915, 1916, 1917, 1918, and 1919 (shipbuilding, shipbreaking, ship repairing, longshoring, and gear certification), which have been specifically excluded from coverage under the plan; enforcement relating to any contractors or subcontractors on any federal establishment where the state cannot obtain entry; enforcement of new federal standards until the state adopts a comparable standard; situations where the state is refused entry and is unable to obtain a warrant or enforce the right of entry; enforcement of unique and complex standards as determined by the Assistant Secretary; situations when the state is temporarily unable to exercise its enforcement authority fully or effectively; completion of enforcement actions initiated prior to the effective date of the agreement; and investigations and inspections for the purpose of evaluating the New Mexico plan. The Regional Administrator for Occupational Safety and Health will make a prompt recommendation for the resumption of federal enforcement authority whenever, and to the degree necessary to assure occupational safety and health protection to employees in New Mexico.

Developmental Schedule:

1952.363

The New Mexico state plan is developmental. The following is the developmental schedule as provided by the plan:

(a) Development of a complete and operating management information and control system by January 1, 1976.

(b) Submission of the state's occupational safety and health poster for approval by January 31, 1976.

(c) Promulgation of rules of procedure for administrative review by the New Mexico Occupational Health and Safety Review Commission by January 31, 1976.

(d) Enforcement program to achieve operational status by December 1, 1976.

(e) Amendments to basic legislation to become effective by July 1, 1977.

(f) Public employee program to become operational by July 1, 1977.

Completed Developmental Steps:

1952.364

(a) The New Mexico state poster was approved by the Assistant Secretary on July 2, 1976. A revised poster was approved October 30, 1984.

(b) New Mexico submitted procedural guidelines for its two-tier contested case procedures in lieu of legislative amendments on December 20, 1977 and June 3, 1983. These procedures establish maximum time frames for completion of the first level, informal administrative review of contested cases, and immediate docketing of cases with the New Mexico Occupational Health and Safety Review Commission. A second 15-day contest period is provided for employer/employee appeal. Amendments added in 1978, 1983, and 1984 deal with the imposition of penalties for serious violations by governmental entities; the private questioning of employees and employers; the jurisdiction of the Environmental Improvement Division over working conditions in copper smelters; the use of interview statements as evidence in civil or enforcement actions; and the state's adoption of emergency tmeporary standards. These clarifications and legislative amendments were approved by the Assistant Secretary October 30, 1984.

(c) New Mexico submitted documentation on establishment of its management information system August 18, 1976 and June 3, 1983, which specified New Mexico's participation in OSHA's unified management information system. These supplements were approved by the Assistant Secretary October 30, 1984.

(d) New Mexico promulgated Review Commission rules of procedure October 1, 1976. Revisions were submitted January 11, 1984, and these were approved October 30, 1984.

(e) New Mexico submitted documentation on December 20, 1977 showing that its enforcement program was operational. This supplement was approved October 30, 1984.

(f) New Mexico submitted a plan supplement regarding development of an occupational safety and health program for public employees in June 1976. A revision, which was submitted February 28, 1980, was approved October 30, 1984.

(g) New Mexico regulations for recording and reporting occupational injuries and illnesses were promulgated August 8, 1975, revised in 1979, 1981, and 1983, and approved October 30, 1984.

(h) New Mexico regulations for inspections, citations, and proposed penalties were promulgated August 8, 1975, revised in 1981, 1982, 1983, and 1984, and approved October 30, 1984.

(i) New Mexico rules of practice for variances, limitations, variations, tolerances, and exemptions were promulgated August 8, 1975, and revised in 1981. Amendments to the field operations manual were passed in 1981 and 1983. These supplements were approved October 30, 1984.

(j) New Mexico promulgated regulations for onsite consultation in 1979 and 1981, with amendments and assurances added in 1983 and 1984. These supplements were approved October 30, 1984.

(k) New Mexico adopted discrimination provisions parallel to the federal in 1982 with an amendment dated June 15, 1983. These supplements were approved October 30, 1984.

(l) New Mexico submitted its field operations manual May 16, 1980, with subsequent amendments in March, May, and June of 1983. The state also adopted the federal industrial hygiene manual These supplements were approved October 30, 1984.

(m) New Mexico submitted a supplement containing a revised plan narrative February 28, 1980, with further revisions added in 1983 and 1984. These supplements were approved October 30, 1984.

(n) The New Mexico occupational safety and health plan was certified as having completed all developmental steps effective December 4, 1984. This certification attests to structural completion but does not render judgement on adequacy of performance.

NORTH CAROLINA

NORTH CAROLINA STATE PLAN OVERVIEW

The North Carolina state occupational safety and health plan was approved February 1, 1973, declared operational February 20, 1975, and certified as having completed all developmental steps October 5, 1976. The plan is enforced by the North Carolina Department of Labor's Occupational Safety and Health Division.

North Carolina adopted all OSHA general industry, construction, and agricultural standards Additional standards have been implemented for shops fabricating structural steel and steel plate

The plan covers all workplaces except the maritime industry and worksites covered by other federal agencies such as the Nuclear Regulatory Commission or the Mine Safety and Health Administration.

Description of the Plan as Initially Approved

1952.150

(a) The Department of Labor has been designated by the governor of North Carolina to administer the plan throughout the state. The Department of Labor has entered into an agreement with the state board of health whereby the state board of health is to assist the Department of Labor in the administration and enforcement of occupational health standards. However, full authority for the promulgation and enforcement of occupational safety and health standards remains with the Department of Labor. The plan defines the covered occupational safety and health issues as defined by the Secretary of Labor in §1902.2(c)(1) of this chapter. Moreover, it is understood that the plan will cover all employers and employees in the state except those whose working conditions are not covered by the federal act by virtue of section 4(b)(1) thereof, dockside maritime and domestic workers. The Department of Labor is currently exercising statewide inspection authority to enforce many state standards. The plan describes procedures for the development and promulgation of additional laws, and orders in all places of employment in the state; the procedures for prompt restraint or elimination of imminent danger conditions; and procedures for inspections in response to complaints.

(b) The plan includes proposed draft legislation to be considered by the North Carolina general assembly during its 1973 session. Such legislation is designed to implement major portions of the plan and to bring it into conformity with the requirements of part 1902 of this chapter.

(c) Under the legislation, all occupational safety and health standards and amendments thereto which have been promulgated by the Secretary of Labor, except those found in parts 1915, 1916, 1917, and 1918 of this chapter (ship repairing, shipbuilding, shipbreaking, and longshoring) will be adopted upon ratification of the proposed legislation. Enforcement of such standards will take place 90 days thereafter.

(d) The legislation will give the Department of Labor full authority to administer and enforce all laws, rules and orders protecting employee safety and health in all places of employment in the state It also proposes to bring the plan into conformity in procedures for providing prompt and effective standards for the protection of employees against new and unforeseen hazards and for furnishing information to employees on hazards, precautions, symptoms, and emergency treatment; and procedures for variances.

(e) The proposed legislation will insure employer and employee representatives an opportunity to accompany inspectors and to call attention to possible violations before, during, and after inspections; protection of employees against discharge or discrimination in terms and conditions of employment; notice to employees and of their protections and obligations; adequate safeguards to protect trade secrets; prompt notice to employers and employees of alleged violations of standards and abatement requirements; effective sanctions against employers; and employer's right to review of alleged violations, abatement periods, and proposed penalties with opportunity for employee participation in the review proceedings.

(f) The plan also provides for the development of a program to encourage voluntary compliance by employers and employees.

(g) The plan includes a statement of the governor's support for the proposed legislation and a statement of legal opinion that it will meet the requirements of the Occupational Safety and Health Act of 1970, and is consistent with the constitution and laws of North Carolina. The plan sets out goals and provides a timetable for bringing it into full conformity with part 1902 upon enactment of the proposed legislation by the state legislature.

(h) The North Carolina plan includes the following documents as of the date of approval:

(1) The plan description document with appendices.

(2) Telegram from the governor of North Carolina, James E. Holshouser, Jr., expressing his full support for the Occupational Safety and Health Act of North Carolina and his anticipation of its passage during the 1973 session of the North Carolina general assembly.

(3) Letter from W.C. Creel, commissioner, North Carolina Department of Labor, to Mr. Thomas C. Brown, director, Federal and State Operations, clarifying several issues raised during the review process.

(4) Also available for inspection and copying with the plan documents will be the public comments received during the review process.

Developmental Schedule

1952.151

The North Carolina plan is developmental. The following is the schedule of the developmental steps provided by the plan:

(a) It is estimated that the draft bill will be enacted by April 1, 1973.

(b) The federal standards will be adopted on the date the bill is ratified.

(c) A refresher course for inspectors will begin sixty (60) days after the enactment of the draft bill.

(d) Merit system examinations of current Department of Labor personnel will be completed within sixty (60) days after federal acceptance of the state plan.

(e) The hiring of new personnel in both the Department of Labor and the state board of health will begin thirty (30) days after the department is assured that state and federal funds are available. Tentative plans provide for both agenices to be fully staffed within six (6) months after the enactment of the bill.

(f) All new personnel will receive official OSHA training in the National Institute of Training. Employment dates will generally correspond to dates established for the institute schools.

(g) Employers and employees will be notified of the availability of consultative services within ninety (90) days after ratification of the draft bill.

(h) The Department of Labor will intitiate a developmental plan for a management information system on the date of plan approval. This program is to be fully implemented in ninety (90) days after enactment of the proposed legislation.

(i) The enforcement of standards will begin ninety (90) days after ratification of the draft bill.

(k) The commissioner will begin issuing administrative "rules and regulations" when necessary as stated in the draft bill ninety (90) days after ratification of the draft bill. Meanwhile, the federal rules and regulations will be adopted and applied until the state rules and regulations are acceptable.

(l) Safety programs for state employees will begin one (1) year and ninety (90) days after ratification of the draft bill, with full implementation scheduled a year later.

(m) Safety programs for large counties and municipalities with over 10,000 population will be initiated ninety (90) days after days draft bill ratification. Full implementation will occur one (1) year later.

(n) Safety programs for other counties and municipalities with 4,000 to 10,000 population will be initiated with two (2) years and ninety (90) days after plan grant is approved. Full implementation will occur three (3) years after grant award.

(o) Safety programs for towns and other governing units having between 1,000 and 4,000 population will be initiated within two (2) years and ninety (90) days after plan grant is approved, with full implementation within three years after grant award.

(p) A state safety and health poster will be prepared within ninety (90) days after ratification of the draft bill.

(q) The state of North Carolina will be fully operational with respect to agriculture 1 year and 90 days after enactment of the draft bill.

Completed Developmental Steps and Certification

1952.152

(a) The Occupational Safety and Health Act of North Carolina (S.B. 342, Chapter 295) was enacted by the state legislature on May 1, 1973, and became effective on July 1, 1973.

(b) The North Carolina occupational safety and health standards identical to federal standards (thru 12-3-74) have been promulgated and approved, as revised, by the Assistant Regional Director on March 11, 1975 (40 FR 11420).

(c) (1) The North Carolina poster for private employers was approved by the Assistant Secretary on April 17, 1975.

(2) The North Carolina poster for public employees was approved by the Assistant Secretary on April 20, 1976.

(d) Full coverage of agricultural workers by the North Carolina Department of Labor began on April 1, 1974.

(e) The state plan has been amended to include an affirmative action plan in which the state outlines its policy of equal employment opportunity.

(f) All North Carolina compliance personnel have completed refresher training courses.

(g) All occupational safety and health personnel in the North Carolina Department of Labor are covered by the state merit system which the U.S. Civil Service Commission has found to be in substantial conformity with the "Standards for a Merit System of Personnel Administration." Agreement with the North Carolina Department of Human Resources specifies that all health personnel cooperating in the state occupational safety and health program are likewise covered by the state merit system.

(h) All North Carolina compliance personnel have attended basic training courses at the OSHA Institute in Chicago.

(i) The North Carolina Department of Labor has publicly disseminated information on the availability on the availability of consultative services.

(j) A manual management information system which provides the quarterly statistical reports required by the Assistant Secretary as well as internal management data has been developed and is fully operational.

(k) State enforcement of standards began on July 1, 1973.

(l) The state has promulgated the following adminitrative rules and regulations:

(1) Regulation 7B.0100: Inspections, citations and proposed penalties.

(2) Regulation 7B.0300: Recording and reporting of occupational injuries and illnesses.

(3) Regulation 7B.0400: Rules of practice for variances.

(4) Regulation 7B.0500: Rules of procedure for promulgating, modifying or revoking occupational safety and health standards.

(5) Regulation 7B.0700: State advisory council on occupational safety and health.

(m) The North Carolina Occupational Safety and Health Review Board has adopted rules of procedure governing its review of contested cases.

(n) Safety programs for state employees were initiated and implemented.

(o) Safety programs for large countries and municipalities with over 10,000 population were initiated and implemented.

PUERTO RICO

PUERTO RICO STATE PLAN OVERVIEW

Puerto Rico's state occupational safety and health plan was approved August 30, 1977, and was certified as having completed all developmental steps effective September 7, 1982. The plan is enforced by the Puerto Rico Department of Labor and Human Resources.

The Puerto Rico state plan is identical to the federal OSHA standards for general industry, construction, and agricultural operations. Excluded are marine and shipyard standards, for which federal OSHA retains enforcement authority.

PUERTO RICO STATE PLAN UPDATE

Description of the Plan
1952.380

(a) The Puerto Rico Department of Labor and Human Resources is the agency responsible for administering and enforcing the state occupational safety and health plan, which applies to public as well as private employees. The plan is essentially identical to federal OSHA standards, except standards for boilers and elevators have been adopted in the absence of federal standards. Marine cargo handling and shipbuilding and ship repairing are excluded from coverage. The plan provides for personnel hiring practices, the management information system, development and promulgation of standards and procedures for eliminating imminent danger situations.

(b) The Puerto Rico plan was enacted July 7, 1975 and approved by the governor August 5, 1975. The act provides employers the right of administrative review of citations, abatement requirements, and proposed penalties, and employee review of abatement dates by a hearing examiner. The decision may be appealed by the employer or employees to the civil courts. The federal compliance manual will be adapted to fit Puerto Rico's law, and a Spanish language version of the standards must be made available within three years of plan approval.

(c) The act provides for inspections in response to employee complaints, employee and representative participation in inspections, employee notification when no compliance action is taken, notification of employees about their rights, protection against discharge or discrimination, trade secret protection, sanctions, right of review, with appeal to the Secretary of Labor and Puerto Rico courts.

(d) A program of voluntary compliance including a provision for onsite consultations is included.

Where the Plan May Be Inspected
1952.381

A copy of the plan may be inspected during normal business hours at the following locations: Office of the Director, Federal Compliance and State Programs, Room N-3112, 200 Constitution Ave. NW, Washington D.C. 20210; Office of the Regional Administrator, Occupational Safety and Health Administration, Room 3445, 1515 Broadway (1 Astor Plaza), New York NY 10036; Department of Labor, Occupational Safety and Health Office, 414 Barbosa Ave., Sixth Floor, Hato Rey PR 00917.

Level of Federal Enforcement
1952.382

Based on a determination that Puerto Rico is operational in the issues covered by the Puerto Rico state occupational safety and health plan, federal enforcement authority will not be initiated with regard to federal occupational safety and health standards covered under parts 1910, 1928, and 1926. The U.S. Department of Labor will continue to exercise authority with respect to complaints filed alleging discrimination under section 11(c) of the Act; standards in the maritime and longshoring industries covered by parts 1915, 1917, 1918, and 1919 which have been specifically excluded from coverage under the plan; enforcement relating to any contractors on federal establishments where the state cannot gain entry; enforcement of unique and complex standards as determined by the Assistant Secretary; situations where the state is temporarily unable to exercise its authority fully or effectively; completion of enforcement actions initiated prior to the effective date of the agreement; and inspections and investigations for evaluating the Puerto Rico plan. The Assistant Regional Director will make a prompt recommendation for resumption of federal enforcement authority whenever, and to the degree necessary to assure occupational safety and health protection to employees in Puerto Rico.

Developmental Schedule
1952.383

The following is the developmental schedule provided by the plan:

(a) Position description of state plan personnel by March 1978;

(b) Public information program (private sector) one year after plan approval;

(c) Analysis for inspection scheduling (private sector), March 1980;

(d) Submit administrative regulations, September 1978;

(e) Affirmative action plan by July 1980;

(f) File and promulgate standards, March 1978;

(g) Adopt the field operations manual, April 1980;

(h) Adopt management information system, January 1980;

(i) Internal training schedule, April 1980;

(j) Employer, employee training schedule, August 1978;

(k) Public information program (government sector), February 1980;

(l) Analysis for inspection scheduling (government sector), June 1980;

(m) Implementation of public employee program, October 1978;

(n) Onsite consultation regulations, March 1979;

(o) Laboratory, August 1980;

(p) Posters, February 1978;

(q) Boiler and elevator program, June 1980;

(r) Staffing for consultation, laboratory, boiler, and elevators, February 1980.

Completed Developmental Steps
1952.384

(a) Puerto Rico's safety and health posters were approved July 2, 1979.

(b) Puerto Rico submitted position descriptions for personnel on March 3, 1980, and revised descriptions on September 8, 1980.

(c) Puerto Rico submitted its public information program for the private sector August 10, 1978.

(d) Puerto Rico submitted its analysis for inspection scheduling in the private sector June 3, 1980.

(e) Puerto Rico submitted its administrative regulations September 13, 1978, and revisions to the regulations on October 27, 1978, March 12, 1979, and February 14, 1980.

(f) Puerto Rico developed an affirmative action plan found acceptable by the U.S. Office of Personnel Management on March 27, 1981.

(g) Puerto Rico promulgated standards identical to federal standards, and subsequent amendments reflect changes in and additions to federal standards.

(h) Puerto Rico submitted its field operations manual on July 31, 1980, and submitted a revised supplement adopting the federal OSHA field operations manual on February 25, 1981.

(i) Puerto Rico has participated in the federal OSHA management information system since August of 1978.

(j) Puerto Rico submitted its internal training schedule May 5, 1980.

(k) Puerto Rico submitted its employer/employee training schedule on March 11, 1980, and an updated schedule on February 13, 1981.

(l) Puerto Rico submitted its public information program for the government sector March 13, 1980.

(m) Puerto Rico submitted its analysis for inspection scheduling in the government sector on August 13, 1980.

(n) Puerto Rico implemented its public employee program in October 1978.

(o) Puerto Rico submitted its onsite consultation regulations on March 30, 1979.

(p) Puerto Rico submitted a state plan supplement on its industrial hygiene laboratory on July 14, 1980.

(q) Puerto Rico submitted its procedures for a boiler and elevator inspection program on November 28, 1979. Based on OSHA recommendations, Puerto Rico submitted a revision deleting the boiler and elevator inspection program from the state plan on November 14, 1980.

(r) Puerto Rico submitted documentation of staffing levels for the onsite consultation program and the industrial hygiene laboratory on March 3, 1980. Based on OSHA recommendations, Puerto Rico deleted staffing for the boiler and elevator inspection program from its state plan on November 14, 1980.

(s) The Puerto Rico occupational safety and health plan was certified effective September 7, 1982, as having completed all developmental steps. This certification attests to structural completion but does not render judgment on adequacy of performance.

SOUTH CAROLINA

SOUTH CAROLINA STATE PLAN OVERVIEW

South Carolina's occupational safety and health plan received initial approval December 6, 1972 and was certified as having completed all developmental steps effective August 3, 1976. The plan is enforced by the South Carolina Department of Labor.

The plan, which is essentially identical to the federal standards, covers both private and public employees in general industry, construction, and agriculture but excludes maritime activities.

SOUTH CAROLINA STATE PLAN UPDATE

Description of the Plan as Initially Approved
1952.90

(a) The South Carolina Department of Labor is the state agency designated to administer the state occupational safety and health plan. The plan includes all federal standards and amendments except those applicable to shipyard and marine terminal work. The plan includes procedures for developing and enforcing additional standards and procedures for imminent danger situations.

(b) The plan includes a statement of the governor's support and sets out goals and a timetable for coming into full conformity with federal requirements.

Developmental Schedule
1952.91

The South Carolina plan is developmental. The following is a schedule of major developmental steps as provided by the plan:

(a) Introduction of the legislative amendments in the legislative session following plan approval.

(b) Public hearings and adoption of federal standards by December 1972.

(c) A management information system by June 30, 1974.

(d) A voluntary compliance program by June 30, 1974.

(e) An occupational safety and health program for public employees by June 30, 1974.

(f) A program for agriculture workers by June 30, 1973.

(g) An approved merit system covering plan personnel to be effective 90 days after plan approval.

(h) A revised compliance manual within six months of plan approval.

Completion of Developmental Steps and Certification
1952.92

(a) Legislative amendments were introduced and enacted June 12, 1973. The amendments have been supplemented by state commitments to take action on all employee discrimination complaints within 90 days and to limit the duration of temporary variances to a maximum of two years, inclusive of any renewals.

(b) South Carolina occupational safety and health standards identical to federal standards have been promulgated and approved effective April 10, 1975.

(c) A voluntary compliance program known as the Taxpayers' Assistant Program has been developed.

(d) Coverage of agricultural workers began July 1, 1973.

(e) The state plan has been amended to show extensions of merit system coverage to the South Carolina Department of Labor, Division of Occupational Safety and Health. All health personnel cooperating in the state occupational safety and health program must likewise be covered by the state merit system.

(f) The South Carolina safety and health poster for private and public employees was approved February 19, 1976.

(g) A management information system has been developed.

(h) The state plan has been amended to include a public employee program for state and local government employees.

(i) The plan has been amended to include an expanded radiation health effort. Inspections covering radiation hazards not covered by the Atomic Energy Act of 1954 will be made by the Division of Radiological Health, South Carolina Department of Health and Environmental Control.

(j) Regulations for enforcement and review of contested cases were revised in order to meet federal requirements.

(k) The state plan has been amended to include an affirmative action plan for equal employment opportunity.

(l) A compliance manual defining procedures and guidelines for consultation staff has been developed.

(m) The South Carolina occupational safety and health plan was certified effective August 3, 1976, as having completed all developmental steps.

Compliance Staffing Benchmarks
1952.93

Compliance staffing levels necessary for a "fully effective" enforcement program needed to be established for each state operating an approved state plan. In September 1984, South Carolina in conjunction with OSHA, completed a reassessment of the levels initially established in 1980 and proposed revised compliance staffing benchmarks of 17 safety and 12 health compliance officers. After opportunity for public comment and service on the AFL-CIO, the Assistant Secretary approved these revised staffing requirements on January 17, 1986.

Level of Federal Enforcement
1952.95

Based on a determination that South Carolina is operational in the issues covered by the South Carolina state occupational safety and health plan, federal enforcement authority will not be initiated with regard to federal occupational safety and health standards for general industry and construction. The U.S. Department of Labor will continue to exercise authority with respect to complaints filed alleging discrimination under section 11(c) of the Act; enforcement of new federal standards until the state adopts a comparable standard; situations where the state is refused entry and is unable to obtain a warrant or enforce the right of entry; enforcement of unique and complex standards; enforcement in situations where the state is temporarily unable to exercise its enforcement authority fully or effectively; enforcement on all active military reservations; enforcement of maritime and longshoring activities; and investigations and inspections for the purpose of evaluating the South Carolina plan. The state shall retain inspection and enforcement authority over any establishment engaged in the construction of vessels and not located upon navigable waters, as well as onshore maritime construction activities not regulated by the Coast Guard or Army Corps of Engineers. The Regional Administrator will make a prompt recommendation for resumption of federal enforcement authority whenever, and to the degree necessary to assure occupational safety and health protection to employees in South Carolina.

Where the Plan May Be Inspected
1952.96

A copy of the principal documents comprising the plan may be inspected and copied during normal business hours at the following locations: Office of State Programs, Occupational Safety and Health Administration, U.S. Dept. of Labor, 200 Constitution Avenue, NW, Room N3476, Washington D.C. 20210; Office of the Regional Administrator, Occupational Safety and Health Administration, U.S. Dept. of Labor, 1375 Peachtree St., NE, Suite 587, Atlanta, GA 30309; and Office of the Commissioner, South Carolina Dept. of Labor, 3600 Forest Drive, P.O. Box 11329, Columbia SC 29211.

TENNESSEE

TENNESSEE STATE PLAN OVERVIEW

The Tennessee state occupational safety and health plan was approved July 5, 1973, certified as having completed developmental steps on May 3, 1978, and received final approval on July 22, 1985. The plan is admnistered by the Tennessee Department of Labor.

The plan is essentially identical to the federal standards, although employees of state and local governments are covered and maritime industry standards are excluded. Also excluded are domestic workers, agricultural workers on family farms, and federal workers covered by other federal safety standards such as the Mine Safety and Health Act.

TENNESSEE STATE PLAN UPDATE

Description of the Plan as Initially Approved
1952.220

(a) The Tennessee Department of Labor and Department of Health are the agencies administering and enforcing the state plan. All federal standards except those in the maritime industries are incorporated into the Tennessee plan.

(b) The plan covers all employees except federal employees, employees covered under other federal safety laws, domestic workers, and agricultural workers employed on a family farm. It includes procedures for developing new standards and procedures for imminent danger situations, and ensures inspections in response to complaints. The plan gives employer and employee representatives the opportunity to accompany compliance officers on inspections; notification of employees or their representative when no action is taken; notification of employee rights and obligations; adequate safeguards for trade secrets; prompt notice of alleged violations and abatement requirements; sanctions for standards violations; employer right of review with employee participation; and coverage of employees of political subdivisions.

(c) Amendments have been added covering permanent variances, protecting employees from discharge or discrimination, imminent danger situations, sanctions, and walkaround. The plan describes the merit system as it relates to personnel, and sets out goals and timetable to bring it in full conformity with federal requirements.

Developmental Schedule
1952.221

The plan is developmental. The following is a schedule of major developmental steps as provided by the plan:

(a) Formal adoption of federal standards (existing state standards were repealed) upon plan approval.

(b) Amendments to legislation to be submitted upon plan approval.

(c) Regulations for recordkeeping and reporting will be promulgated upon plan approval.

(d) Regulations for inspections, citations, and proposed penalties will be promulgated upon plan approval.

(e) Variance regulations to be promulgated within 60 days of plan approval.

(f) Manual management data system operational July 1, 1973. Automated management data system operational January 1, 1974.

Completion of Developmental Steps and Certification
1952.222

(a) The plan was amended and approved in August 1975. Further amendments transferring all occupational safety and health responsibility to the Commissioner of Labor were approved May 3, 1978.

(b) Regulations governing inspections, citations, and proposed penalties were approved, revised, and reapproved in 1978.

(c) Regulations governing temporary variances were approved, expanded to include permanent variances, and amended in response to federal comment, and then reapproved in 1978.

(d) The Tennessee occupational safety and health poster for private employers and local government employers choosing to be treated as private employers was approved August 15, 1975. A Tennessee occupational safety and health poster for public employees was approved May 3, 1978.

(e) The Tennessee occupational safety and health standards identical to federal standards were approved March 31, 1975.

(f) The manual management information system was implemented in July 1973 and converted to an automated system in July 1975.

(g) Regulations governing recordkeeping and reporting were amended and approved May 3, 1978.

(h) Regulations covering operation of the Tennessee Occupational Safety and Health Review Commission were passed, amended, and approved on May 3, 1978.

(i) Tennessee revised its original compliance operations manual was approved May 3, 1978.

(j) A Tennessee public employee plan was adopted and approved May 3, 1978.

(k) The Tennessee occupational safety and health plan was certified as having completed all developmental steps effective May 3, 1978.

Compliance Staffing Benchmarks
1952.223

Compliance staffing levels necessary for a "fully effective" enforcement program needed to be established for each state operating an approved state plan. In September 1984, Tennessee in conjunction with OSHA completed a reassessment of the levels initially established in 1980 and proposed revised compliance staffing benchmarks of 22 safety and 14 health compliance officers. After opportunity for public comment and service on the AFL-CIO, the Assistant Secretary approved these revised staffing requirements on July 22, 1985.

Final Approval Determination
1952.224

(a) In accordance with section 18(e) of the Act and procedures in 29 CFR Part 1902, and after a determination that the state met the "fully effective" compliance staffing benchmarks as revised in 1984 in response to a court order, and was satisfactorily providing reports to OSHA through participation in the federal-state unified management information system, the Assistant Secretary evaluated actual operations under the Tennessee state plan for at least one year following certification of completion of developmental steps. Based on the evaluation report for October 1982 through March 1984, and after opportunity for public comment and an informal public hearing, the Assistant Secretary determined that in operation, the state of Tennessee occupational safety and health program is at least as effective as the federal program in providing safe and healthful employment and places of employment and meets the criteria for final state plan approval. Accordingly, the Tennessee plan was granted final approval and concurrent federal enforcement authority was relinquished effective July 22, 1985.

(b) The plan covers all activities of employers and all places of employment in Tennessee except: private sector maritime employment, railroad employment, employment at Tennessee Valley Authority facilities and on military bases, as well as any other properties ceded to the United States government.

(c) Tennessee is required to maintain a state program which is at least as effective the federal program, to submit plan supplements in accordance with 29 CFR Part 1953, to allocate sufficient safety and health enforcement staff to meet the benchmarks for state staffing established by the U.S. Dept. of Labor, or any revisions to those benchmarks, and to furnish such reports in such form as the Assistant Secretary may from time to time require.

Level of Federal Enforcement
1952.225

(a) As a result of the granting of final approval to the Tennessee plan, occupational safety and health standards which have been promulgated under section 6 of the Act do not apply to issues covered under the Tennessee plan. This determination also relinquishes concurrent federal OSHA authority to issue citations for violation of such standards under sections 5(a)(2) and 9 of the Act; to conduct inspections and investigations under section 8 [except those necessary to evalute the plan under section 18 or other inspections, investigations, or proceedings necessary to carry out federal responsibilities not preempted by section 18(e)]; to conduct enforcement proceedings in contested cases under section 10; to institute proceedings to correct imminent dangers under section 13; and to propose civil penalties or initiate criminal proceedings for violations of the federal Act under section 17. The Assistant Secretary may retain jurisdiction over any proceeding commenced under section 9 or 10 before July 22, 1985.

(b) In accordance with section 18(e), final approval relinquishes federal OSHA authority only with regard to occupational safety and health issues covered by the Tennessee plan. OSHA retains full authority over issues which are not subject to state enforcement under the plan. Thus, federal OSHA retains its authority relative to safety and health in private sector maritime activities and will continue to enforce all provisions of the Act, rules or orders, and all federal standards, current or future, specifically directed to maritime employment (29 CFR Part 1915, shipyard employment; Part 17, marine terminals; Part 1918, longshoring; and Part 1919, gear certification) as well as provisions of general industry standards appropriate to hazards found in these employments; railroad employment not otherwise regulated by another federal agency, employment at Tennessee Valley Authority facilities, and on military bases. Federal jurisdiction is also retained with respect to federal government employers and employees. In addition, any hazard, industry, geographical area, operation, or facility over which the state is unable to effective exercise jurisdiction shall be subject to federal enforcement. Where enforcement is shared between federal and state authorities, federal jurisdiction may be assumed over the entire project or facility, upon agreement of federal and state OSHA.

(c) Federal authority under provisions of the Act not listed in section 18(e) is not affected by final approval of the plan. Thus, for example, the Assistant Secretary retains his authority under section 11(c) of the Act with regard to complaints alleging discrimination against employees who exercise any right afforded to them by the Act, although such complaints may be referred to the state for investigation. The Assistant Secretary also retains the authority to promulgate, modify, or revoke occupational safety and health standards which address the working conditions of all employees, including those in states which have received a final approval determination, although such standards may not be federally applied. In the event that the state's 18(e) status is subsequently withdrawn, and federal authority reinstated, all federal standards including any standards promulgated or modified during the 18(e) period would be federally enforceable in that state.

(d) OSHA will continue to monitor the operations of the Tennessee state program to assure that the provisions of the state plan are substantially complied with and that the program remains at least as effective as the federal program. Failure by the state to comply with its obligations may result in the revocation of the final determination under section 18(e), resumption of federal enforcement and/or proceedings for withdrawal of plan approval.

Where the Plan May Be Inspected
1952.226

A copy of the principal documents comprising the plan may be inspected and copied during normal business hours at the following locations: Office of State Programs, Occupational Safety and Health Administration, U.S. Dept. of Labor, 200 Constitution Avenue, NW., Room N3476, Washington D.C. 20210; Regional Administrator, Occupational Safety and Health Administration, U.S. Department of Labor, 1375 Peachtree Street, NE, Suite 587, Atlanta GA 30309; and Office of the Commissioner, Tennessee Department of Labor, 501 Union Building, Suite "A" - 2nd floor, Nashville TN 37210

UTAH

UTAH STATE PLAN OVERVIEW

The Utah state occupational safety and health plan was approved July 30, 1972, certified as having completed all developmental steps November 19, 1976, and granted final approval July 16, 1985. The plan is enforced by the Utah Industrial Commission.

The plan is essentially identical to the federal general industry and construction standards, although employees of state and local governments are covered and maritime industry standards are excluded. Utah also retained some state health and safety standards covering conditions either not mentioned or not fully covered in the federal standards, such as safety committees, flammable solids, dust collectors, pesticides, dry cleaners, emergency showers, industrial railroads, and many others.

UTAH STATE PLAN UPDATE

Description of the Plan as Initially Approved
1952.110

(a) The Utah Industrial Commission is the state agency in charge of administering the state plan. The plan provides for rulemaking, developing of safety standards, enforcement, and procedures for complaints and imminent danger situations. The plan is essentially identical to the federal standards. The plan gives employer and employee representatives the opportunity to accompany compliance officers on inspections; protection of employees against discharge or discrimination; notification of employee rights and obligations; adequate safeguards for trade secrets; prompt notice of alleged violations and abatement requirements; sanctions for standards violations; and employer right of review with the opportunity for employee participation.

(b) The plan, which includes a statement of the governor's support, sets out goals and a timetable for meeting federal requirements.

Developmental Schedule
1952.111

The plan is developmental. The following is a schedule of major developmental steps as provided by the plan:

(a) Introduction of legislation to state legislature, January 1973.

(b) Enactment of the enabling legislation by March 1973.

(c) Formal adoption of federal standards and revocation of existing state standards by September 1, 1973.

(d) Adoption of safety standards for agriculture by September 1, 1974.

(e) Formal adoption of parts 1903, 1904, and 1905 as rules and regulations by July 1974.

(f) Effective date of new standards, commencement of state enforcement by September 1973.

(g) A management information system by July 1, 1974.

Completion of Developmental Steps and Certification
1952.112

(a) The Utah state poster was approved January 7, 1976.

(b) The state developed and implemented a management information system.

(c) The Utah Occupational Safety and Health Act was approved July 30, 1972, and became effective July 1, 1973.

(d) State regulations identical to parts 1903, 1904, and 1905 were adopted and approved on March 3, 1976.

(e) Rules of procedure for the review commission were developed and implemented.

(f) The state plan has been amended to include an affirmative action plan outlining the state's policy of equal opportunity.

(g) Utah has promulgated standards at least as effective as the federal standards regarding all issues covered by the plan.

(h) The Utah occupational safety and health plan was certified effective November 19, 1976 as having completed all developmental steps.

Compliance Staffing Benchmarks
1952.113

Compliance staffing levels necessary for a "fully effective" enforcement program needed to be established for each state operating an approved state plan. In September 1984, Utah in conjunction with OSHA, completed a reassessment of the levels initially established in 1980 and proposed revised compliance staffing benchmarks of 10 safety and 9 health compliance officers. After opportunity for public comment and service on the AFL-CIO, the Assistant Secretary approved these revised staffing requirements on July 16, 1985.

Final Approval Determination
1952.114

(a) In accordance with section 18(e) of the Act and procedures in 29 CFR Part 1902, and after a determination that the state met the "fully effective" compliance staffing benchmarks as revised in 1984 in response to a court order, and was satisfactorily providing reports to OSHA through participation in the federal-state unified management information system, the Assistant Secretary evaluated actual operations under the Utah state plan for at least one year following certification of completion of developmental steps. Based on the evaluation report for October 1982 through March 1984, and after opportunity for public comment and an informal public hearing, the Assistant Secretary determined that in operation, the state of Utah occupational safety and health program is at least as effective as the federal program in providing safe and healthful employment and places of employment and meets the criteria for final state plan approval. Accordingly, the Utah plan was granted final approval and concurrent federal enforcement authority was relinquished effective July 16, 1985.

(b) The plan covers all activities of employers and all places of employment in Utah except: private sector maritime employment and Hill Air Force Base.

(c) Utah is required to maintain a state program which is at least as effective the federal program, to submit plan supplements in accordance with 29 CFR Part 1953, to allocate sufficient safety and health enforcement staff to meet the benchmarks for state staffing established by the U.S. Dept. of Labor, or any revisions to those benchmarks, and to furnish such reports in such form as the Assistant Secretary may from time to time require.

Level of Federal Enforcement
1952.115

(a) As a result of the granting of final approval to the Utah plan, occupational safety and health standards which have been promulgated under section 6 of the Act do not apply with respect to issues covered under the Utah plan. This determination also relinquishes concurrent federal OSHA authority to issue citations for violations of such standards under sections 5(a)(2) and 9 of the Act; to conduct inspections and investigations under section 8 [except those necessary to evalute the plan under section 18(f) or other inspections, investigations, or proceedings necessary to carry out federal responsibilities not preempted by section 18(e)]; to conduct enforcement proceedings in contested cases under section 10; to institute proceedings to correct imminent dangers under section 13; and to propose civil penalties or initiate criminal proceedings for violations of the federal Act under section 17. The Assistant Secretary may retain jurisdiction over any proceeding commenced under section 9 or 10 before July 16, 1985.

(b) In accordance with section 18(e), final approval relinquishes federal OSHA authority only with regard to occupational safety and health issues covered by the Utah plan. OSHA retains full authority over issues which are not subject to state enforcement under the plan. Thus, federal OSHA retains its authority relative to safety and health in private sector maritime activities and will continue to enforce all provisions of the Act, rules or orders, and all federal standards, current or future, specifically directed to maritime employment (29 CFR Part 1915, shipyard employment; Part 17, marine terminals; Part 1918, longshoring; and Part 1919, gear certification) as well as provisions of general industry standards appropriate to hazards found in these employments. Federal jurisdiction is also retained on the Hill Air Force Base, and with respect to all federal government employers and employees. In addition, any hazard, industry, geographical area, operation, or facility over which the state is unable to effectively exercise jurisdiction shall be subject to federal enforcement. Where enforcement is shared between federal and state authorities, federal jurisdiction may be assumed over the entire project or facility, upon agreement of federal and state OSHA.

(c) Federal authority under provisions of the Act not listed in section 18(e) is not affected by final approval of the plan. Thus, for example, the Assistant Secretary retains his authority under section 11(c) of the Act with regard to complaints alleging discrimination against employees who exercise any right afforded to them by the Act, although such complaints may be referred to the state for investigation. The Assistant Secretary also retains the authority to promulgate, modify, or revoke occupational safety and health standards which address the working conditions of all employees, including those in states which have received a final approval determination, although such standards may not be federally applied. In the event that the state's 18(e) status is subsequently withdrawn, and federal authority reinstated, all federal standards including any standards promulgated or modified during the 18(e) period would be federally enforceable in that state.

(d) OSHA will continue to monitor the operations of the Utah state program to assure that the provisions of the state plan are substantially complied with and that the program remains at least as effective as the federal program. Failure by the state to comply with its obligations may result in the revocation of the final determination under section 18(e), resumption of federal enforcement and/or proceedings for withdrawal of plan approval.

Where the Plan May Be Inspected
1952.226

A copy of the principal documents comprising the plan may be inspected and copied during normal business hours at the following locations: Office of State Programs, Occupational Safety and Health Administration, U.S. Dept. of Labor, 200 Constitution Avenue, NW., Room N3476, Washington D.C. 20210; Regional Administrator, Occupational Safety and Health Administration, U.S. Department of Labor, 1961 Stout Street, Room 1554, Denver CO 80294; and the Office of the Utah Industrial Commission, Utah Occupational Safety and Health, 160 E. Third South, Salt Lake City UT 84110-5800.

VERMONT

VERMONT STATE PLAN OVERVIEW

The Vermont state occupational safety and health plan, submitted to OSHA in 1972, was certified as having completed all developmental steps effective March, 1977. The Vermont plan, which is essentially identical to the federal OSHA standards, applies to both public and private employees and is enforced by the Department of Labor and Industry.

VERMONT STATE PLAN UPDATE

Description of the Plan
1952.270

(a) The Vermont state program is administered and enforced by the Department of Labor and Industry. Safety standards are developed by the Commissioner of Labor and Industry, while health standards are developed by the Secretary of the Agency of Human Services.

(b) The state program protects all Vermont workers, including state employees.

(c) Vermont has adopted all federal OSHA standards. New standards are adopted within one year after being passed by federal OSHA.

(d) The Vermont plan became law on July 1, 1972, and includes general authority and scope for implementation, as well as regulations patterned after 29 C.F.R. Parts 1903, 1904, and 1905.

(e) The plan provides for standards setting, employee notification of hazards, emergency treatment, and variances. It gives employer and employee representatives the opportunity to accompany inspectors and call attention to possible violations before, during, and after inspections, and protects employees against discharge or discrimination in terms or conditions of employment. When no compliance action is taken upon complaints, including informal review, the plan provides for employee notification. The plan requires employees be notified of their protections and obligations; provides adequate safeguards to protect trade secrets; requires prompt notice to employers and employees of alleged violations of standards and abatement requirements; outlines effective sanctions against employers; provides the right to review alleged violations, abatement periods, and proposed penalties with the opportunity for employee participation in the review proceedings; provides for prompt restraint or elimination of imminent danger conditions, and outlines programs to encourage voluntary compliance by employers and employees.

(f) The plan includes a statement of the governor's support, and sets out goals and a timetable for bringing the plan into full federal compliance. Personnel hired under the state's merit system will carry out the program.

Where the Plan May be Inspected
1952.271

A copy of the Vermont plan may be inspected and copied during normal business hours at the following locations: U.S. Dept. of Labor, Office of Federal and State Operations, Occupational Safety and Health Administration, 1726 M Street, NW, Washington DC 20210; Regional Office, Occupational Safety and Health Administration, 18 Oliver St., Fifth floor, Boston MA 02110; Department of Labor and Industry, State Office Building, Montpelier VT 05602.

Level of Federal Enforcement
1952.272

Federal enforcement authority in Vermont will not change until the state has promulgated rules for the operation of the Occupational Safety and Health Review Board and until certain other administrative regulations are passed.

Developmental Schedule
1952.273

(a) Amendments to Vermont's Occupational Safety and Health Act introduced and enacted in the 1974 session of the state legislature.

(b) Completion of the state's compliance manual.

(c) Drafting of rules governing the operation of the Occupational Safety and Health Review Board.

(d) Development of administrative procedures for implementing the program within the state agencies.

(e) Development of the state's Voluntary Compliance Program for Employers and Employees.

(f) Appointment of advisory committees for safety and health standards upon plan approval.

(g) Within three years of plan approval all developmental steps will be fully implemented.

Completed Developmental Steps
1952.274

(a) Amendments to the Vermont plan were passed April 3, 1974.

(b) Rules governing the operation of the Occupational Safety and Health Review Board were adopted effective January 1974.

(c) The Vermont Standards Advisory Council was established in January 1984.

(d) The following developmental steps have been implemented:

  (1) The health and safety enforcement program was implemented November 12, 1973.

  (2) The Vermont Occupational Safety and Health Review Board was established in October 1973, under rules formally passed and approved in 1974.

  (3) Recordkeeping and reporting requirements were implemented for both private and public sectors November 12, 1973.

  (4) Written procedures for coordinating the Divisions of Occupational Safety and Occupational Health were formulated and revised in 1975.

(e) The Vermont safety and health poster was approved on February 9, 1977.

(f) Vermont has developed a field operations manual which defines the procedures and guidelines to be used by the Vermont compliance staff in carrying out the goals of the program, which was approved February 22, 1977.

(g) Vermont has developed and implemented a state enforcement program by November 12, 1973 which was approved February 22, 1977.

(h) The voluntary compliance program was developed and implemented by February 1974, and approved February 22, 1977.

(i) The Vermont occupational safety and health plan was certified, effective March 4, 1977, as having completed all developmental steps.

VIRGINIA

VIRGINIA STATE PLAN OVERVIEW

Virginia's occupational safety and health plan received initial approval September 28, 1976 and was certified as having completed all developmental steps effective August 15, 1984. The plan is enforced by the Virginia Department of Labor and Industry.

The plan, which is essentially identical to the federal standards, covers both private and public employees in general industry, construction, and agriculture but excludes maritime activities. Although initially Virginia elected to keep its own standards on ionizing radiation, in 1982 it adopted standards identical to the federal standards on ionizing radiation.

VIRGINIA STATE PLAN UPDATE

Description of the Plan as Initially Approved
1952.370

(a) The Virginia Department of Labor and Industry is the agency responsible for administering the plan, with the Virginia Department of Health responsible for occupational health matters. All federal standards are incorporated except for maritime standards. New federal standards will be added within six months of passage.

(b) (1) The plan includes legislation and amendments by the Virginia legislature. The Department of Labor and Industry will issue citations, set abatement dates, and issue summons and/or warrants for a civil district court determination of violations and assessment of proposed penalties for safety and health violations. Appeals shall be to the circuit court sitting without a jury. Fire safety inspections and enforcement will be provided by agreement with the state fire marshal. All employees, including public employees, are covered by the plan except for maritime workers, federal employees, and workers whose workplaces are regulated by federal agencies other than OSHA.

(2) The legislation insures inspections in response to employee complaints; right of employer and employee representatives to accompany inspectors; notification to employees or their representatives when no compliance action is taken as a result of alleged violations; notification to employees of their protections and obligations; protection of employees against discharge or discrimination in terms and conditions of employment; adequate safeguards to protect trade secrets; prompt notice to employers and employees of alleged violations of standards and abatement requirements; outlines effective sanctions against employers; provides the right to review alleged violations, abatement periods, and proposed penalties with the opportunity for employee participation in the review proceedings; provides for prompt restraint or elimination of imminent danger conditions, and a program to encourage voluntary compliance by employers and employees (including provision for onsite consultation).

(c) The plan sets out goals and a timetable for meeting federal requirements. A merit system of personnel administration will be used.

Developmental Schedule
1952.371

The Virginia plan is developmental. Follwing is a schedule of major developmental steps:

(a) Standards identical to the federal standards will be adopted by January 1, 1978.

(b) A plan for delegation of authority to the state fire marshal for fire standards development and enforcement will be completed by December 31, 1976 with necessary legislative action and program implementation by July 1, 1978.

(c) State posters informing public and private employees of their rights and responsibilities will be developed and distributed within six months of plan approval.

(d) A voluntary compliance program (including onsite consultation services) will be initiated within six months of plan approval.

(e) Both safety and health compliance programs will be fully staffed by FY 1979.

(f) Both safety and health consultation programs will be fully staffed by FY 1979.

(g) An automated management information system, including a court reporting system, will be developed within six months of plan approval.

(h) An administrative procedures manual containing state regulations on standards promulgation, inspections, citations, proposal of penalties, review procedures, variances, etc., will be developed within six months of plan approval.

(i) A compliance manual establishing procedures to be used by safety and health inspectors and voluntary compliance personnel will be developed within six months of plan approval.

(j) THe state is now responsible for enforcing the state explosive code. That code will be amended within six months of plan approval to contain only standards identical to OSHA standards.

(k) Job descriptions for safety and health personnel will be reviewed and revised to reflect job functions within 12 months of plan approval.

(l) The directors of the Industry and Construction Safety Divisions in the Department of Labor and Industry will be brought under state merit system coverage by January 1, 1977.

(m) An inspection scheduling system will be developed for the health program within six months of plan approval and for the safety program within eight months of plan approval.

(n) A public employee program will be developed and implemented within six months of plan approval.

Completion of Developmental Steps
1952.372

(a) Virginia announced that the authority for fire standards enforcement will rest with the Department of Labor and Industry, which has been enforcing fire standards since plan approval, rather than with the state fire marshal. This action is judged to have sufficiently fulfilled the commitments of this step.

(b) Virginia's safety and health posters for public and private employers were approved November 13, 1980.

(c) Virginia initiated a voluntary compliance program including onsite consultation services March 15, 1977. (The state subsequently arranged for onsite consultation activities for the private sector to be covered by an agreement with the U.S. Department of Labor.)

(d) Virginia met its commitments for staffing the onsite consultation rpogram in the public sector by FY 1979.

(e) Virginia developed and implemented an automated management information system on July 1, 1977.

(f) The directors of Industry and the Construction Safety Divisions have been placed under the state's merit system as of September 1, 1976.

(g) State standards identical to the federal standards in general industry, construction, and agriculture were adopted and approved. In August 1982 the state adopted standards identical to the federal standards for ionizing radiation. Virginia has continued to adopt standards, amendments, and corrections identical to the federal standards.

(h) Virginia met its staffing commitments for its compliance program with 38 safety and 18 health compliance officers. This supplement was approved October 14, 1983.

(i) Virginia met its commitments for developing and implementing a reporting system for court decisions resulting from contested cases. This system was approved October 14, 1983.

(j) Virginia submitted revised standards for explosives and blasting agents March 23, 1977, which were identical to the federal standards and were approved March 17, 1978.

(k) Virginia met its commitment of reviewing job descriptions for safety and health personnel by submitting revised specifications on October 5, 1977. This was approved October 14, 1983.

(l) Virginia submitted its inspection scheduling system for health and safety inspections, which were later revised to meet the federal health and safety scheduling system. This plan was approved October 14, 1983.

(m) Virginia submitted an administrative procedures manual outlining standards promulgation, inspections, recordkeeping, nondiscrimination, citations, proposal of penalties, review, and variance procedures. In response to OSHA comments, revisions to the manual have been submitted and were approved August 15, 1984.

(n) A compliance manual for compliance officers was submitted, revised, and then the state decided to use the federal field operations manual and industrial hygiene field operations manual. This decision was approved August 15, 1984.

(o) Virginia developed and implemented an occupational safety and health program for public employees, which was approved August 15, 1984.

(p) Virginia submitted legislative amendments dealing with the commissioner's delegation authority, judicial review procedures, and penalty provisions, which were approved August 15, 1984.

(1) The Virginia occupational safety and health plan was certified effective August 15, 1984 as having completed all developmental steps. This certification attests to structural completion but does not render judgment on adequacy of performance.

Compliance Staffing Benchmarks
1952.363

Compliance staffing levels necessary for a "fully effective" enforcement program needed to be established for each state operating an approved state plan. In September 1984, Virginia in conjunction with OSHA completed a reassessment of the levels initially established in 1980 and proposed revised compliance staffing benchmarks of 38 safety and 21 health compliance officers. After opportunity for public comment and service on the AFL-CIO, the Assistant Secretary approved these revised staffing requirements on January 17, 1986.

Level of Federal Enforcement
1952.365

Based on a determination that Virginia is operational in the issues covered by the Virginia state occupational safety and health plan, federal enforcement authority will not be initiated with regard to federal occupational safety and health standards for general industry and construction. The U.S. Department of Labor will continue to exercise authority with respect to complaints filed alleging discrimination under section 11(c) of the Act; standards in maritime and longshoring which have been excluded from coverage; enforcement relating to federal contractors or subcontractors where the state cannot obtain entry; enforcement of new federal standards until the state adopts a comparable standard; situations where the state is refused entry and is unable to obtain a warrant or enforce the right of entry; enforcement of unique and complex standards; enforcement in situations where the state is temporarily unable to exercise its enforcement authority fully or effectively; completion of enforcement action initiated before the effective date of the agreement; and investigations and inspections to evaluate the Virginia plan. The Regional Administrator will make a prompt recommendation for resumption of federal enforcement authority whenever, and to the degree necessary to assure occupational safety and health protection to employees in Virginia.

Where the Plan May Be Inspected
1952.376

A copy of the principal documents comprising the plan may be inspected and copied during normal business hours at the following locations: Office of State Programs, Occupational Safety and Health Administration, U.S. Dept. of Labor, 200 Constitution Avenue, NW, Room N3476, Washington D.C. 20210; Regional Administrator, Occupational Safety and Health Administration, U.S. Dept. of Labor, Gateway Building — Suite 2100, 3535 Market St., Philadelphia PA 19104; and Office of the Commissioner, Virginia Dept. of Labor and Industry, P.O. Box 12064, 205 North 4th St., Richmond VA 23241-0064.

VIRGIN ISLANDS

VIRGIN ISLANDS STATE PLAN OVERVIEW

The Virgin Islands state occupational safety and health plan was approved on September 11, 1973, certified as having completed all developmental steps on August 31, 1976, and granted final approval April 17, 1984. The plan is enforced by the Virgin Islands Department of Labor

Although the Virgin Islands adopted most of the federal OSHA standards, like many other states it excluded private sector maritime employment. Also, the Virgin Islands plan excludes all occupational health and environmental controls regulations for general industry and construction. The asbestos dust standard for general industry and the gear certification standard (29 C.F.R. Part 1919) were also not adopted. The plan covers both private and public employees

VIRGIN ISLANDS STATE PLAN UPDATE

Description of the Plan as Initially Approved
1952.250

(a) The Virgin Islands occupational safety and health program is administered and enforced by the Virgin Islands Department of Labor, and covers all private and public employments except as described below.

(b) (1) The plan requires employers of one or more employees to furnish employment and a place of employment free from hazards, and to comply with all occupational state safety and health standards. The plan also directs employees to comply with standards applicable to their own actions.

(2) Owners, lessors, agents, or managers of premises used in whole or in part as places of employment must also comply with state safety and health standards.

(c) The plan provides for standards setting, employee notification of hazards, emergency treatment, and variances. It gives employer and employee representatives the opportunity to accompany inspectors and call attention to possible violations before, during, and after inspections, and protects employees against discharge or discrimination in terms or conditions of employment. When no compliance action is taken upon complaints, including informal review, the plan provides for employee notification. The plan requires employees be notified of their protections and obligations; provides adequate safeguards to protect trade secrets; requires prompt notice to employers and employees of alleged violations of standards and abatement requirements; outlines effective sanctions against employers; provides the right to review alleged violations, abatement periods, and proposed penalties with the opportunity for employee participation in the review proceedings; provides for prompt restraint or elimination of imminent danger conditions, and procedures for inspection in response to complaints.

(d) (1) The plan includes a legal opinion that it will meet federal requirements for state plans, and is consistent with the laws of the Virgin Islands.

(2) A merit system of personnel administration will be used.

(3) A program of education, training, and consultation for employers and employees will be developed.

(4) The plan is supplemented by implementing legislation and a revised timetable.

Developmental Schedule
1952.251

The following is a summary of the major developmental steps provided by the plan:

(a) Commencement of recruitment and staff training — September 10, 1973.

(b) Effective date of implementing legislation — October 1, 1973.

(c) Procedural and interpretative regulations and standards to become effective — January 1, 1974.

(d) Enforcement program to be operational — January 1, 1974.

(e) Public employee program to be operational — July 15, 1975.

Completed Developmental Steps
1952.252

(a) Amendments to the Virgin Islands legislation were passed March 11 and February 26, 1974.

(b) The Virgin Islands occupational safety and health standards were promulgated on March 21, 1974.

(c) The Virgin Islands has completed the training described.

(d) The Virgin Islands has developed and implemented a manual management information system.

(e) The Virgin Islands safety and health posters were approved September 28, 1976.

(f) The Virgin Islands has developed and implemented an effective public information program.

(g) The Virgin Islands amended its legislation to delete reference to "political subdivisions" and substitute the term "department;" and to add new sections: "Variations, Tolerances, and Exemptions" and "Disclosure of Confidential Trade Secrets."

(h) The Virgin Islands field operations manual modeled after the federal manual has been developed and approved.

(i) The Virgin Islands has developed an acceptable organizational chart; job description for occupational safety and health employees meeting the necessary requirements; a procedure to correct a problem of understaffing in the Virgin Islands in terms of plan commitment; a procedure for rating and making candidates; and an affirmative action plan for equal employment opportunity acceptable to CSC.

(j) The Virgin Islands implemented the public employee program in July 1975.

(k) The Virgin Islands adopted the administrative regulations on March 11, 1974.

(l) The safety enforcement program in the Virgin Islands was operational in April 1974.

(m) The Virgin Islands occupational safety and health plan was certified as having completed all developmental steps August 31, 1976. This certification attests to structural completion but does not render judgment on adequacy of performance.

Final Approval Determination
1952.253

(a) In accordance with section 18(e) of the Act and procedures in 29 CFR Part 1902, and after a determination that the state met the "fully effective" compliance staffing benchmarks as revised in 1984 in response to a court order, and was satisfactorily providing reports to OSHA through participation in the federal-state unified management information system, the Assistant Secretary evaluated actual operations under the Virgin Islands state plan for at least one year following certification of completion of developmental steps. Based on the evaluation report for 1982 and available 1983 data, and after opportunity for public comment and an informal public hearing, the Assistant Secretary determined that in operation, the state of Virgin Islands occupational safety and health program is at least as effective as the federal program in providing safe and healthful employment and places of employment and meets the criteria for final state plan approval. Accordingly, the Virgin Islands plan was granted final approval and concurrent federal enforcement authority was relinquished effective April 17, 1984.

(b) The plan covers all activities of employers and all places of employment in Virgin Islands except private sector maritime employment and occupational health.

(c) The Virgin Islands are required to maintain a state program which is at least as effective the federal program, to submit plan supplements in accordance with 29 CFR Part 1953, to allocate sufficient safety and health enforcement staff to meet the benchmarks for state staffing established by the U.S. Dept. of Labor, or any revisions to those benchmarks, and to furnish such reports in such form as the Assistant Secretary may from time to time require.

Level of Federal Enforcement
1952.254

(a) As a result of the granting of final approval to the Virgin Islands plan, occupational safety and health standards which have been promulgated under section 6 of the Act do not apply with respect to issues covered under the Virgin Islands plan. This determination also relinquishes concurrent federal OSHA authority to issue citations for violation of such standards under sections 5(a)(2) and 9 of the Act; to conduct inspections and investigations under section 8 [except those necessary to evalute the plan under section 18(f) or other inspections, investigations, or proceedings necessary to carry out federal responsibilities not preempted by section 18(e)]; to conduct enforcement proceedings in contested cases under section 10; to institute proceedings to correct imminent dangers under section 13; and to propose civil penalties or initiate criminal proceedings for violations of the federal Act under section 17. The Assistant Secretary may retain jurisdiction over any proceeding commenced under section 9 or 10 before April 17, 1984.

(b) In accordance with section 18(e), final approval relinquishes federal OSHA authority only with regard to occupational safety and health issues covered by the Virgin Islands plan. OSHA retains full authority over issues which are not subject to state enforcement under the plan. Thus, federal OSHA retains its authority relative to safety and health in private sector occupational health and maritime activities and will continue to enforce all provisions of the Act, rules or orders, and all federal standards, current or future, specifically directed to those employments. Federal jurisdiction also remains in effect for federal government employers and employees.

(c) Federal authority under provisions of the Act not listed in section 18(e) is not affected by final approval of the plan. Thus, for example, the Assistant Secretary retains his authority under section 11(c) of the Act with regard to complaints alleging discrimination against employees who exercise any right afforded to them by the Act, although such complaints may be referred to the state for investigation. The Assistant Secretary also retains the authority to promulgate, modify, or revoke occupational safety and health standards which address the working conditions of all employees, including those in states which have received a final approval determination, although such standards may not be federally applied. In the event that the state's 18(e) status is subsequently withdrawn, and federal authority reinstated, all federal standards including any standards promulgated or modified during the 18(e) period would be federally enforceable in that state.

(d) OSHA will continue to monitor the operations of the Virgin Islands state program to assure that the provisions of the state plan are substantially complied with and that the program remains at least as effective as the federal program. Failure by the state to comply with its obligations may result in the revocation of the final determination under section 18(e), resumption of federal enforcement and/or proceedings for withdrawal of plan approval.

Where the Plan May Be Inspected
1952.255

A copy of the principal documents comprising the plan may be inspected and copied during normal business hours at the following locations: Office of State Programs, Occupational Safety and Health Administration, U.S. Dept. of Labor, 200 Constitution Avenue, NW, Room N3700, Washington DC 20210; Regional Administrator, Occupational Safety and Health Administration, U.S. Dept. of Labor, 1515 Broadway (1 Astor Plaza), Room 3445, New York NY 10036; Office of the Commissioner, Virgin Islands Dept. of Labor, Division of Occupational Safety and Health, Hospital St., Christiansted, St. Croix VI 00820.

WASHINGTON

WASHINGTON STATE PLAN OVERVIEW

Washington's occupational safety and health plan received initial approval January 26, 1973 and was certified as having completed all developmental steps effective January 26, 1982. The plan is enforced by the Washington Department of Labor and Industries.

Washington elected to keep its own state job safety and health standards which were judged at least as effective as federal standards. A comparison between state and federal standards is included in the plan documents. The plan covers both private and public employees in general industry, construction, and agriculture but excludes maritime activities.

WASHINGTON STATE PLAN UPDATE

Description of the Plan
1952.120

(a) (1) The Department of Labor and Industries is the state agency responsible for enforcing the plan throughout the state. The plan contains a comparison of federal and state standards. All federal standards except for maritime standards shall be adopted.

(2) The plan provides for personnel employed under a merit system, coverage of public employees, standards setting procedures, and procedures for controlling imminent danger situations.

(b) (1) The plan includes legislation which will bring it into conformity with federal requirements.

(2) The legislation also insures inspections in response to complaints; gives employer and employee representatives an opportunity to accompany inspectors in order to aid inspections; notifies employees or their representatives when no compliance action is taken as a result of alleged violations (including informal review); notifies employees of their protections and obligations; protects employees from discharge or discrimination; protects trade secrets; provides for prompt notice to employers and employees of alleged violations and abatement requirements; provides for effective sanctions against employers for violations; gives employer right of review to the Board of Industrial Insurance Appeals and then to the courts, with employee participation in review proceedings allowed. The plan also encourages voluntary compliance by employers and employees, providing for onsite consultations, as well.

(c) The plan includes a statement of the governor's support and a legal opinion from the state attorney general that the plan meets federal requirements and is consistent with the constitution and laws of Washington. The plan sets out goals and a timetable for meeting federal requirements.

Where the Plan May Be Inspected
1952.121

A copy of the principal documents comprising the plan may be inspected and copied during normal business hours at the following locations: U.S. Dept. of Labor, Office of Federal and State Operations, Occupational Safety and Health Administration, Room 800, 1726 M Street NW, Washington D.C. 20210; Assistant Regional Director, Occupational Safety and Health Administration, Room 1813, Smith Tower Bulding, 506 Second Ave., Seattle WA 98104; and Supervisor, Division of Safety, Dept. of Labor and Industries, 308 East 4th Ave., P.O. Box 207, Olympia WA 93504.

Level of Federal Enforcement
1952.122

Based on a determination that Washington is operational in the issues covered by the Washington state occupational safety and health plan, federal enforcement authority will not be initiated with regard to federal occupational safety and health standards for general industry and construction. The U.S. Department of Labor will continue to exercise authority with regard to federal standards passed after the agreement where necessary to protect employees (as in the case of temporary emergency standards) until Washington has passed equivalent standards; federal maritime standards as they relate to federal government employment; complaints about violations of the discrimination provisions of Section 11(c); and investigations and inspections conducted to evaluate the Washington plan. The Regional Administrator will make a prompt recommendation for resumption of federal enforcement authority whenever, and to the degree necessary to assure occupational safety and health protection to employees in Washington.

Developmental Schedule
1952.123

The Washington state plan is developmental. The following is the developmental schedule:

(a) Introduction of the legislation in the 1973 legislative session.

(b) Public hearings and promulgation of standards within one year after being found at least as effective as federal standards by OSHA.

(c) Promulgation and adoption of rules and regulations for assuming obligations and functions within one year of effective date.

(d) Development and implementation of a management information system six months after plan approval.

(e) Achievement of training objectives by December 31, 1973.

(f) Upgrading of salaries of personnel in Division of Safety.

Completed Developmental Steps and Certification
1952.124

(a) The Washington Industrial Safety and Health Act was approved July 3, 1974.

(b) The Washington state poster was approved August 3, 1983.

(c) The Washington state compliance operations manual, modeled after the federal field operations manual, was approved August 3, 1983.

(d) Washington regulations covering reassumption of jurisdiction were approved March 19, 1976.

(e) Washington completed the training described in this section.

(f) Washington developed and implemented a computerized management information system.

(g) Washington completed the upgrading of salaries of safety personnel.

(h) Washington adopted rules and regulations covering recordkeeping and reporting requirements.

(i) An industrial hygiene operations manual, modeled after the federal manual was approved January 26, 1982.

(j) Administrative regulations providing for inspections; abatement date extensions; variances; employee complaints; posting of citations and notices; contested cases; posting of notices; settlements; settlement agreements; and meeting federal requirements were adopted and approved August 3, 1983.

(k) The Washington state occupational safety and health plan was certified effective January 26, 1982 as having completed all developmental steps. This certification attests to structural completion but does not render judgment on adequacy of performance.

Changes to Approved Plans
1952.125

(a) The following changes to the recordkeeping and reporting requirements of the Washington plan were approved August 5, 1980:

(1) The state now provides for use of an OSHA Form 200 or its equivalent.

(2) The state now provides access to records for present and former employees.

(3) The state exempts employers of 10 or fewer employees from maintaining a log, summary, and supplementary record of occupational injuries and illnesses unless selected for participation in a statistical survey.

WYOMING

WYOMING STATE PLAN OVERVIEW

The Wyoming state occupational safety and health plan was approved May 3, 1974, certified as having completed all developmental steps effective December 30, 1980, and granted final approval June 27, 1985. The plan is enforced by the Wyoming Occupational Safety and Health Commission.

The plan is essentially identical to the federal general industry and construction standards, although employees of state and local governments are covered and maritime industry standards are excluded. Additional standards covering oil well drilling and servicing not found in the federal standards were also adopted by the state.

WYOMING STATE PLAN UPDATE

Description of the Plan as Initially Approved
1952.340

(a) The Wyoming Occupational Health and Safety Commission is the agency responsible for administering the plan throughout the state. The commission is responsible for standards setting and deciding contested cases.

(b) The plan covers all employees in the state including public employees. Federal employees or employees whose working conditions are regulated by other federal agencies are not covered.

(c) The plan gives the state full authority to enforce all laws protecting employee safety and health. The plan gives employer and employee representatives the opportunity to accompany compliance officers on inspections; gives adequate safeguards for trade secrets; provides effective sanctions against employers; protects employees against discharge or discrimination; provides for control of imminent danger situations; allows employer right of review with the opportunity for employee participation; and provides for prompt notice of alleged violations and abatement requirements.

(d) Administrative regulations include procedures for permanent and temporary variances, notice to employees or their representatives when no compliance action is taken as a result of a complaint, including procedures for informal review; information to employees on hazards, precautions, symptoms, and emergency treatment; and training and education programs for employers and employees, including an onsite consultation program.

(e) The state will cover federal general industry and construction standards but not maritime standards. Also, the state plans to adopt standards not in the federal standards on well drilling and servicing.

(f) The plan sets out goals and a timetable for reaching full federal compliance. All personnel employed to carry out the plan are to be hired under a merit system conforming to federal standards.

Developmental Schedule
1952.341

(a) Adoption of federal standards by February 1975.

(b) Administrative regulations for recordkeeping and reporting, variances, posting requirements, employee complaint procedures, inspections, employee exposure to toxic substances, providing information to employees exposed to hazards, personal protective equipment, medical examinations, monitoring, safeguarding trade secrets, administrative review of citations, proposed penalties, and abatement periods to become effective by June 1, 1974.

(c) Amendments to be submitted to the state legislature and become effective by May 1, 1975.

(d) Management information system to be completed by August 15, 1974.

(e) Merit staffing for administration to be completed by August 15, 1974.

(f) Amendments to the state's Fair Employment Practices Act to be submitted January 1975.

Completed Developmental Steps
1952.342

(a) Federal standards were adopted in 1975 (except maritime).

(b) The Wyoming posters for private and public employees were approved July 14, 1976.

(c) Wyoming developed and implemented a management information system.

(d) The state plan was amended to include an affirmative action plan outlining the state's policy of equal employment opportunity.

(e) Guidelines and procedures for the safety and health program for public employees were approved June 1, 1978.

(f) Wyoming passed rules of practice and procedures which were approved December 11, 1980.

(g) Legislation revising the law to provide for civil enforcement and review of enforcement actions was approved December 19, 1980.

(h) The state hired enforcement staff under an approved merit system.

(i) The personnel operations were found to conform to federal merit system requirements on October 17, 1980.

(j) The Wyoming occupational safety and health plan was certified effective December 30, 1980 as having completed all developmental steps. This certification attests to structural completion but does not render judgment on adequacy of performance.

Compliance Staffing Benchmarks
1952.343

Compliance staffing levels necessary for a "fully effective" enforcement program needed to be established for each state operating an approved state plan. In September 1984, Wyoming in conjunction with OSHA completed a reassessment of the levels initially established in 1980 and proposed revised compliance staffing benchmarks of 6 (six) safety and 2 (two) health compliance officers. After opportunity for public comment and service on the AFL-CIO, the Assistant Secretary approved these revised staffing requirements on June 27, 1985.

Final Approval Determination
1952.344

(a) In accordance with section 18(e) of the Act and procedures in 29 CFR Part 1902, and after a determination that the state met the "fully effective" compliance staffing benchmarks as revised in 1984 in response to a court order, and was satisfactorily providing reports to OSHA through participation in the federal-state unified management information system, the Assistant Secretary evaluated actual operations under the Wyoming state plan for at least one year following certification of completion of developmental steps. Based on the evaluation report for October 1982 through March 1984, and after opportunity for public comment and an informal public hearing, the Assistant Secretary determined that in operation, the state of Wyoming occupational safety and health program is at least as effective as the federal program in providing safe and healthful employment and places of employment and meets the criteria for final state plan approval. Accordingly, the Wyoming plan was granted final approval and concurrent federal enforcement authority was relinquished effective June 27, 1985.

(b) The plan covers all activities of employers and all places of employment in Wyoming except: private sector maritime employment, Warren Air Force Base, and private sector hazardous waste disposal facilities designated as Superfund sites.

(c) Wyoming is required to maintain a state program which is at least as effective the federal program, to submit plan supplements in accordance with 29 CFR Part 1953, to allocate sufficient safety and health enforcement staff to meet the benchmarks for state staffing established by the U.S. Dept. of Labor, or any revisions to those benchmarks, and to furnish such reports in such form as the Assistant Secretary may from time to time require.

Level of Federal Enforcement
1952.345

(a) As a result of the granting of final approval to the Wyoming plan, occupational safety and health standards which have been promulgated under section 6 of the Act do not apply with respect to issues covered under the Wyoming plan. This determination also relinquishes concurrent federal OSHA authority to issue citations for violations of such standards under sections 5(a)(2) and 9 of the Act; to conduct inspections and investigations under section 8 [except those necessary to evalute the plan under section 18(f) or other inspections, investigations, or proceedings necessary to carry out federal responsibilities not preempted by section 18(e)]; to conduct enforcement proceedings in contested cases under section 10; to institute proceedings to correct imminent dangers under section 13; and to propose civil penalties or initiate criminal proceedings for violations of the federal Act under section 17. The Assistant Secretary may retain jurisdiction over any proceeding commenced under section 9 or 10 before June 27, 1985.

(b) In accordance with section 18(e), final approval relinquishes federal OSHA authority only with regard to occupational safety and health issues covered by the Wyoming plan. OSHA retains full authority over issues which are not subject to state enforcement under the plan. Thus, federal OSHA retains its authority relative to safety and health in private sector maritime activities and will continue to enforce all provisions of the Act, rules or orders, and all federal standards, current or future, specifically directed to maritime employment (29 CFR Part 1915, shipyard employment; Part 17, marine terminals; Part 1918, longshoring; and Part 1919, gear certification) as well as provisions of general industry standards appropriate to hazards found in these employments. Federal jurisdiction is also retained for employment at Warren Air Force Base, at private sector hazardous waste disposal facilities designated as Superfund sites, and with respect to all federal government employers and employees. In addition, any hazard, industry, geographical area, operation, or facility over which the state is unable to effectively exercise jurisdiction shall be subject to federal enforcement. Where enforcement is shared between federal and state authorities, federal jurisdiction may be assumed over the entire project or facility, upon agreement of federal and state OSHA.

(c) Federal authority under provisions of the Act not listed in section 18(e) is not affected by final approval of the plan. Thus, for example, the Assistant Secretary retains his authority under section 11(c) of the Act with regard to complaints alleging discrimination against employees who exercise any right afforded to them by the Act, although such complaints may be referred to the state for investigation. The Assistant

Secretary also retains the authority to promulgate, modify, or revoke occupational safety and health standards which address the working conditions of all employees, including those in states which have received a final approval determination, although such standards may not be federally applied. In the event that the state's 18(e) status is subsequently withdrawn, and federal authority reinstated, all federal standards including any standards promulgated or modified during the 18(e) period would be federally enforceable in that state.

(d) OSHA will continue to monitor the operations of the Wyoming state program to assure that the provisions of the state plan are substantially complied with and that the program remains at least as effective as the federal program. Failure by the state to comply with its obligations may result in the revocation of the final determination under section 18(e), resumption of federal enforcement and/or proceedings for withdrawal of plan approval.

Where the Plan May Be Inspected
1952.345

A copy of the principal documents comprising the plan may be inspected and copied during normal business hours at the following locations: Office of State Programs, Occupational Safety and Health Administration, U.S. Dept. of Labor, 200 Constitution Avenue, NW., Room N3476, Washington D.C. 20210; Regional Administrator, Occupational Safety and Health Administration, U.S. Department of Labor, 1961 Stout Street, Room 1554, Denver CO 80294; and Office of the Wyoming Dept. of Occupational Health and Safety, 604 East 25th St., Cheyenne WY 82002.

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